

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
10 July 2003 (10.07.2003)

PCT

(10) International Publication Number  
**WO 03/056560 A1**

(51) International Patent Classification<sup>7</sup>: **G11B 27/34, H04N 5/445**

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(21) International Application Number: **PCT/JP02/13414**

(22) International Filing Date:  
24 December 2002 (24.12.2002)

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(25) Filing Language: English

(81) Designated States (*national*): CN, KR.

(26) Publication Language: English

(84) Designated States (*regional*): European patent (DE, FR, GB).

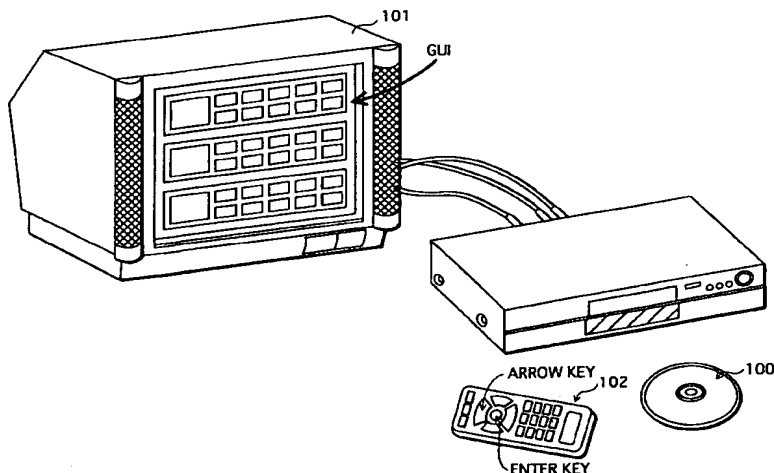
(30) Priority Data:  
JP NO. 2001-391464  
25 December 2001 (25.12.2001) JP

Published:  
— with international search report

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

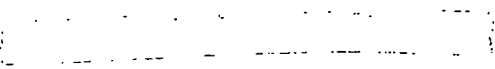
(54) Title: APPARATUS, METHOD, AND COMPUTER-READABLE PROGRAM FOR PLAYING BACK CONTENT



(57) Abstract: A GUI generating unit displays a GUI screen listing a plurality of sets of video content. A playback controlling unit performs a playback operation on a set of video content which is selected by a user on the GUI screen, and keeps a history of a playback start position and a playback stop position. A GUI updating unit updates the GUI screen and displays it, after the playback operation by the playback controlling unit. To update the GUI screen, a thumbnail generating unit chooses a plurality of pieces of picture data from between the playback start position and the playback stop position in the set of video content, and places thumbnails of these pieces of picture data on the GUI screen.

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## DESCRIPTION



APPARATUS, METHOD, AND COMPUTER-READABLE PROGRAM FOR  
5 PLAYING BACK CONTENT

## TECHNICAL FIELD

The present invention relates to an apparatus for playing back video content (moving pictures), and in particular relates to improvements in helping a user recall the contents of video content which he or she has already viewed.

## BACKGROUND ART

15 Recording media like DVDs and HDs are often used to record, week after week, broadcast content such as a drama series that is put on the air every week. Playback apparatuses which have made their market debuts in recent years are equipped with a well-developed content listing function, to aid a user to view a plurality of sets of content recorded in such a way. This listing function can display information about each set of content recorded on the recording medium, such as a recording date and time, a broadcast channel, and 20 a broadcast title, thereby helping the user understand 25

what is recorded on the recording medium. The listing function can also display the last image of the previous playback or a bar chart showing the playback stop position of the previous playback, thereby helping the user recall the previous playback.

When viewing a drama series which is aired weekly, it is important for the user to remember the previous week's episode, such as what the psychological states and actions of the characters in that episode were. If the user does not remember this, he or she may not be able to concentrate on this week's episode.

The same applies to the case when such a drama series is recorded on a recording medium and later the user views the recorded content. Suppose the user has previously viewed up to some episode, and now wants to resume from where he or she has stopped last time. If the user does not clearly recall until which episode he or she has watched or what the psychological states and actions of the characters in that episode were, the user may not be able to concentrate on the viewing.

The user's memory of the psychological states and actions of the characters in one episode derives from his or her fresh impressions upon watching that episode, and therefore tends to become less clear as time passes. This being so, when the user views the next episode after

some time, he or she may find it difficult to fully concentrate on the viewing. In such a case, just displaying information such as the recording date and time of the content using the above listing function does  
5 not much help the user recall the contents of the previous episode. Equally, just displaying the last image of the previous playback or the bar chart showing the playback stop position of the previous playback does not much help the user.

10 Since the listing function is not enough to evoke the user's memory of the previous episode, the user needs to rewind or fast-forward to the previous scenes, in order to recall the contents of the viewed part. If the user has already viewed a lot of episodes, such a  
15 procedure is very troublesome, and the user may lose the desire to continue the viewing.

The above explanation uses a drama series as one example, but the same problem can be found with regard to other content such as educational programs and sports.  
20 Suppose the user has previously viewed up to some point of a sports event, and now wants to resume from where he or she has stopped last time. If the user does not clearly remember what happened in the viewed part, he or she may not be able to fully enjoy viewing the  
25 following part. If a large number of sets of content

are recorded on a recording medium but the user cannot recall the contents of these sets of content, the user may lose the desire to view the recorded content.

Eventually, the user may even lose the desire to record  
5 content on a recording medium.

#### DISCLOSURE OF THE INVENTION

The present invention aims to provide a playback apparatus that can help a user instantly recall the  
10 contents of video content, such as an episode in a drama series, which he or she has previously viewed.

The stated object can be achieved by a playback apparatus for playing back video content that includes a plurality of pieces of picture data, including: a  
15 displaying unit operable to display a menu which lists a plurality of sets of video content; a playback unit operable to play back one of the plurality of sets of video content which is selected from the menu by a user, and keep a history of a playback start position and a  
20 playback stop position; and an updating unit operable to update the menu and have the displaying unit display the updated menu, after the playback by the playback unit, wherein the update is performed by choosing at least one piece of picture data from between the playback start  
25 position and the playback stop position in the set of

video content, and placing a thumbnail of each chosen piece of picture data in the menu.

With this construction, thumbnails of pieces of picture data chosen from within a part of video content which the user has previously viewed are displayed. Suppose the user has viewed up to some episode of a drama series several weeks ago and now wants to resume from where he or she has stopped last time. This being so, from the display of thumbnails of pieces of picture data chosen from the viewed part, the user can easily recall until which episode he or she has viewed last time or what the psychological states and actions of the characters in that episode were. Hence the user can concentrate on further viewing.

Here, if another thumbnail already exists in the menu, the updating unit may place the thumbnail adjacent to the other thumbnail.

Here, when the playback by the playback unit is a  $p$ th playback operation performed on the set of video content,  $p$  being an integer no smaller than 2, the other thumbnail may be a thumbnail of a piece of picture data which is located between a playback start position and a playback stop position of a  $(p-1)$ th playback operation performed on the set of video content.

Suppose at least one playback operation has

previously been performed on the video content. Then the thumbnails of the pieces of picture data chosen from the viewed part are displayed adjacent to thumbnails of pieces of picture data chosen from a viewed part of the  
5 previous playback operation. This produces a thumbnail display that resembles a bar chart. From such a display, the user can easily grasp the progress of playback of each set of video content.

Here, a number of thumbnails which the updating  
10 unit places in the menu may depend on a ratio of a playback time length from the playback start position to the playback stop position to a total playback time length of the set of video content.

Here, the menu may have a plurality of navigation  
15 areas which are in a one-to-one correspondence with the plurality of sets of video content, wherein each navigation area is given an upper limit to a number of placeable thumbnails, and the number of thumbnails which the updating unit places in a navigation area  
20 corresponding to the set of video content is a number obtained by multiplying an upper limit given to the navigation area by the ratio.

When there are a plurality of sets of video content, as many thumbnails as possible are displayed in a  
25 navigation area corresponding to the video content.

This enables the user to clearly recall the contents of the viewed part.

Here, each chosen piece of picture data may be one of a plurality of pieces of picture data that are present  
5 at intervals of  $\Delta t$  starting from a beginning of the set of video content and is located between the playback start position and the playback stop position, wherein  $\Delta t$  is a value obtained by dividing the total playback time length of the set of video content by the upper  
10 limit.

With this construction, the user can not only recall the contents of the viewed part from the displayed thumbnails, but also grasp the progress of playback of the video content from the number of displayed thumbnails.  
15 Therefore, from the thumbnail display the user can not only recall what the psychological states and actions of the characters in the previous episode were, but also know to what extent he or she has viewed the video content.

20 Here, each navigation area may have the same upper limit to the number of placeable thumbnails.

Here, each chosen piece of picture data may be present at intervals of  $\Delta t$  starting from the playback start position, wherein  $\Delta t$  is a value obtained by  
25 dividing a playback time length from the playback start



position to the playback stop position by a predetermined value.

Interval  $\Delta t$  with which the pieces of picture data should be chosen is calculated by dividing the playback  
5 time length of the viewed part by the upper limit to the number of placeable thumbnails. In this way,  $\Delta t$  can be set long if the viewed part is long, and short if the viewed part is short.

Here, the menu may have a plurality of navigation  
10 areas which are in a one-to-one correspondence with the plurality of sets of video content, wherein each navigation area is given the same upper limit to a number of placeable thumbnails, and the predetermined value is the same upper limit.

15 With this construction, the upper limit to the number of placeable thumbnails is the same for each set of video content. In so doing, even when a viewed part of some video content is extremely long, the screen will not be filled with thumbnails of pieces of picture data  
20 of that video content.

Here, the at least one piece of picture data chosen by the updating unit may be a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from the playback start position, wherein  $\Delta t$  is shorter  
25 near the playback stop position than near the playback

start position.

With this construction, interval  $\Delta t$  is shorter near the playback stop position than near the playback start position. This enables more thumbnails to be used for  
5 the latter portion of the viewed part. Hence the user can clearly recall what the psychological states and actions of the characters in the previous episode were.

Here, the updating unit may choose a plurality of pieces of picture data from between the playback start  
10 position and the playback stop position, and place a plurality of thumbnails of the respective plurality of pieces of picture data one after another in the menu so that the plurality of thumbnails are displayed like a slide show.

15 With this construction, for each set of video content two or more thumbnails are displayed one after another like a slide show. Accordingly, even when there are a large number of sets of video content, the user can easily understand the contents of each set of video  
20 content.

Here, the playback start position may be a beginning of the set of video content or a position where the user requests to resume playing back the set of video content, and the playback stop position may be a position  
25 where the user requests to stop playing back the set of

video content or an end of the set of video content.

Here, the playback stop position may be a position where the user requests to switch from a normal playback mode to a special playback mode, and the playback start  
5 position may be a position where the user requests to switch from the special playback mode back to the normal playback mode.

If the user views the video content while skipping some parts by fast forward or the like, the pieces of  
10 picture data are chosen only from the viewed parts and not from the skipped parts. Hence thumbnails of those skipped parts will not be displayed on the screen.

#### BRIEF DESCRIPTION OF DRAWINGS

15 FIG. 1 shows an outward appearance of a DVD and a playback apparatus to which the first embodiment of the invention relates.

FIGS. 2A and 2B show an inner construction of the playback apparatus.

20 FIG. 3 shows an example of a program navigation area.

FIG. 4A is a flowchart of a main routine of a microcomputer system shown in FIG. 2.

FIG. 4B is a flowchart of a subroutine called in  
25 step S1 in FIG. 4A, and shows processing of a GUI

generating unit in the microcomputer system.

FIG. 5 is a flowchart of a subroutine called in step S7 in FIG. 4A, and shows processing of a playback controlling unit in the microcomputer system.

5        FIGS. 6A and 6B are a flowchart of a subroutine called in step S8 in FIG. 4A, and show processing of a GUI updating unit and thumbnail generating unit in the microcomputer system.

10       FIG. 7 shows program navigation areas on a GUI screen, when content 1 to content 3 have not been played at all.

FIG. 8 shows how the program navigation areas are updated when content 1 has been played from the beginning up to the 1240sec point.

15       FIG. 9 is a representation of a process of choosing pieces of picture data and reducing these pieces of picture data.

20       FIG. 10 shows how the program navigation areas are updated when content 1 has been played up to the 2200sec point.

FIG. 11 shows how the program navigation areas are updated when content 1 has been played to the end and content 2 has been played from the beginning up to the 1000sec point.

25       FIG. 12 shows how the program navigation areas are

updated when all of content 1 to content 3 have been played.

FIG. 13 shows a layout of thumbnails, in the case where the number of sets of content recorded on the DVD  
5 has increased.

FIGS. 14A-14F show how thumbnails are displayed one after another like slides, in the layout shown in FIG. 13.

FIGS. 15A and 15B are a flowchart of a main routine  
10 of the microcomputer system in the second embodiment of the invention.

FIG. 16 is a flowchart showing processing of the GUI generating unit in the second embodiment.

FIG. 17 is a flowchart showing processing of the  
15 thumbnail generating unit in the second embodiment.

FIG. 18 is a flowchart showing processing of the GUI updating unit in the second embodiment.

FIG. 19 shows how array elements  $H[0]$ ,  $H[1]$ ,  $H[2]$ ,  $H[3]$ , ... with time intervals of  $T/u \cdot v$  are determined, when  
20  $u$  is 4 and  $v$  is any of 1 to 4.

FIG. 20 is a flowchart showing processing of the GUI updating unit and the thumbnail generating unit in the third embodiment.

FIG. 21A shows how array elements  $H[0]$ ,  $H[1]$ ,  $H[2]$ ,  $H[3]$ , ... are determined, when  $T$  and  $u$  are given specific  
25

values.

FIG. 21B shows how thumbnails are placed in a program navigation area, when array elements H[0], H[1], H[2], H[3], ... are determined as shown in FIG. 21A.

5        FIG. 22A shows example playback where a point of switching from normal playback to fast forward is set as a playback stop time and a point of switching from fast forward to normal playback is set as a playback start time.

10       FIG. 22B shows an example of playback history stored in a work area shown in FIG. 2, when the playback shown in FIG. 22A has been performed.

15       FIG. 23 is a flowchart of a main routine of the microcomputer system in the fourth embodiment of the invention.

FIG. 24 is a flowchart showing processing of the GUI updating unit in the fourth embodiment.

20       FIG. 25 shows a construction of a streaming delivery system to which the fifth embodiment of the invention relates.

FIG. 26 is a sequence chart of the delivery system.

FIG. 27 is a sequence chart of the delivery system.

FIG. 28 shows an inner structure of VR\_MANGR.IFO.

FIG. 29 shows an inner structure of TMAPI.

25       FIG. 30 is a representation of the relationship

between TMAPI and VOBUs.

FIG. 31 shows an inner structure of an ORG\_PGCI table.

FIG. 32 shows the relationship between VOBs and  
5 cells included in ORG\_PGCI.

FIG. 33 shows how the cells shown in FIG. 32 are grouped in PGs.

FIG. 34 shows how partial areas of VOBs are specified when partial deletes have been performed on  
10 the VOBs.

FIG. 35 shows VOBs obtained after the partial deletes.

#### BEST MODE FOR CARRYING OUT THE INVENTION

##### 15 (First Embodiment)

The following describes embodiments of a playback apparatus of the present invention. First, an example application of the playback apparatus of the present invention is described below, with reference to FIG. 1.

20 In FIG. 1, the playback apparatus, a television 101, and a remote control 102 together constitute a home theater system. The playback apparatus is used to select video content recorded on a DVD 100 and play back it, based on a GUI (Graphical User Interface) screen  
25 displayed on the television 101 and user operations on

the remote control 102.

The DVD 100 is an optical disc on which a plurality of sets of video content are recorded by a recording apparatus (not shown in the drawing). In the DVD 100, each set of video content is associated with a date and time when the content was recorded, a channel at which the content was broadcast, and a title of the content. Video content is made up of at least one VOB (Video Object) and management information for the VOB. A VOB is a program stream obtained by interleave-multiplexing video and audio streams. A video stream is made up of a plurality of pieces of picture data which are compression-encoded. An audio stream is made up of a plurality of pieces of audio data which are compression-encoded. Though video content includes not only a VOB but also management information for the VOB as mentioned above, an explanation on management information is omitted in the first to fifth embodiments for simplicity's sake. Hence the first to fifth embodiments are described on the assumption that a VOB itself is video content.

The television 101 displays the GUI screen for selecting video content recorded on the DVD 100, and playback images of the selected video content.

The remote control 102 is a device for receiving



user operations directed to the GUI screen, and is equipped with arrow keys and the ENTER key.

FIGS. 2A and 2B show an inner construction of the playback apparatus of the present invention. As shown in the drawings, the playback apparatus includes a DVD drive 1, an ASP 2, a DSP 3, an MPEG decoder 4, a system decoder 5, an audio decoder 6, a video decoder 7, frame memories 8a, 8b, and 8c, an order controlling unit 9, a signal combining unit 10, a microcomputer system 11, a GUI generating unit 12, a playback controlling unit 13, a work area 14, a GUI updating unit 15, and a thumbnail generating unit 16.

First, a hardware construction of the playback apparatus is explained below, by referring to FIG. 2A.

The DVD drive 1 is equipped with a tray 1a, a loading motor 1b, a spindle motor 1c, an optical pickup 1d, and a tracking motor 1e. The tray 1a holds the DVD 100. The loading motor 1b moves the tray 1a back and forth. The spindle motor 1c rotates the DVD 100 on the tray 1a. The tracking motor 1e drives the optical pickup 1d in the radial direction of the DVD 100. The optical pickup 1d includes a laser diode 1f for applying a laser beam on the rotating DVD 100, and a photodiode 1g for receiving light reflected from the DVD 100.

The ASP (Analog Signal Processor) 2 controls the

spindle motor 1c and the tracking motor 1e so that the optical pickup 1d moves to an address indicated by the microcomputer system 11.

5 The DSP (Digital Signal Processor) 3 controls the spindle motor 1c so as to keep a constant rotational speed of the DVD 100. The DSP 3 also performs binarization, 8/16 demodulation, and error correction on an RF signal read by the optical pickup 1d, thereby obtaining a digital signal.

10 The MPEG decoder 4 is a dedicated circuit for decoding a VOB (video content) in the digital signal obtained by the DSP 3. The MPEG decoder 4 includes the system decoder 5, the audio decoder 6, and the video decoder 7.

15 The system decoder 5 demultiplexes VOBUs (Video Object Units). A VOB is the minimum unit of decoding of a VOB. A VOB contains a GOP (Group Of Pictures) that is a collection of picture data with a playback period of around 0.4 to 1.0 second, as well as a plurality of  
20 audio frames that should be played back at the same time as this GOP. The system decoder 5 demultiplexes each VOB, thereby obtaining a GOP and a plurality of audio frames.

The audio decoder 6 decodes the plurality of audio  
25 frames to obtain an audio signal.

The video decoder 7 performs VLD (Variable Length Decoding), IQ (Inverse Quantization), IDCT (Inverse Discrete Cosine Transform), MC (Motion Compensation), and the like on B (Bidirectionally Predicted) pictures, P (Predicted) pictures, and I (Intra Coded) pictures that constitute the GOP. As a result, the video decoder 7 obtains uncompressed digital picture data, and stores it to the frame memories 8a-8c.

The frame memories 8a-8c are provided respectively for the three types of picture data that are I pictures, B pictures, and P pictures. The frame memories 8a-8c separately store the uncompressed picture data obtained by decompressing these three types of picture data.

The order controlling unit 9 sequentially reads the uncompressed picture data stored in the frame memories 8a-8c, with timings shown by PTSs (Presentation Time Stamps) which are attached to the picture data. The order controlling unit 9 converts the read picture data to a video signal, and outputs it. On the DVD 100, a plurality of pieces of picture data that constitute video content are arranged in an encoding order. To play back such video content, the plurality of pieces of picture data need be rearranged in a display order. To do so, the order controlling unit 9 reads the I pictures, P pictures, and B pictures stored in the frame memories

8a-8c, in the order shown by the PTSs.

The order controlling unit 9 also outputs the PTSs attached to the picture data, sequentially to the microcomputer system 11. These PTSs are used for  
5 keeping the playback history of the video content, as explained later.

The signal combining unit 10 combines the picture data with GUI data, thereby obtaining a television image signal. The GUI data referred to here is OSD (On Screen  
10 Display) data. OSD data is simple graphics drawn using two to four colors shown in a LUT (Look-Up Table) as the background and character colors. The signal combining unit 10 mixes the horizontal lines that form the uncompressed picture data with the horizontal lines that  
15 form the OSD data, to combine the picture data with the OSD data. Here, the signal combining unit 10 can conceal the picture data with the GUI data or make the picture data visible through the GUI data, depending on the mixture ratio.

20 The microcomputer system 11 includes a CPU 11a, an instruction ROM 11b storing programs to be executed by the CPU 11a, and a RAM 11c used for the execution of the programs. The microcomputer system 11 controls the overall playback apparatus, by executing the programs  
25 stored in the instruction ROM 11b through the CPU 11a.

Next, a software construction of the playback apparatus is explained below, by referring to FIG. 2B.

The programs stored in the instruction ROM 11b are coded to achieve the functions of "playback control", "GUI generation", and "GUI update". When the CPU 11a reads the programs stored in the instruction ROM 11b, the playback controlling unit 13, the GUI generating unit 12, and the GUI updating unit 15 shown in FIG. 2B are realized. The RAM 11c is used as the work area 14 by these units. The GUI generating unit 12, the playback controlling unit 13, and the GUI updating unit 15 are described in detail below.

The GUI generating unit 12 generates a GUI screen and displays it. The GUI generating unit 12 also controls the overall playback apparatus, in accordance with user operations. The GUI screen has a plurality of display areas. A program navigation area for visually expressing video content recorded on the DVD 100 is provided in each of these display areas. FIG. 3 shows an example program navigation area. A program navigation area 300 shown in the drawing is an expanded and detailed version of a program navigation area that is displayed on the television 101 in FIG. 1. As illustrated, the program navigation area 300 is made up of an index area 301 and a thumbnail area 302. A

recording date and time, channel, and title of video content are placed in the index area 301. The program navigation area 300 has three states, namely, a normal state, a focus state, and an active state. The normal  
5 state refers to a state where the content is not selected by the user. The focus state refers to a state where the content is brought into focus as a candidate for the playback target, using the arrow keys on the remote control 102. The active state refers to a state where  
10 the content is selected as the playback target using the ENTER key on the remote control 102. The GUI generating unit 12 instructs the playback controlling unit 13 to play back video content that is set in the active state on the GUI screen.

15 The playback controlling unit 13 controls the MPEG decoder 4 and the DVD drive 1 to play back the video content which is selected as the playback target by the user. This playback of the video content is continued until the user presses the STOP key on the remote control  
20 102. The playback controlling unit 13 also keeps a history of a start time and stop time of this playback operation. In detail, the playback controlling unit 13 sets the value of the first PTS output from the order controlling unit 9 after instructing the MPEG decoder  
25 4 and the DVD drive 1 to play back the video content,

as the start time of the playback operation. Also, the playback controlling unit 13 sets the value of the first PTS output from the order controlling unit 9 after instructing the MPEG decoder 4 and the DVD drive 1 to  
5 stop playing back the video content, as the stop time of the playback operation. The playback controlling unit 13 then writes the combination of the start time and stop time in the work area 14. If the same video content is selected as the playback target again, the  
10 playback controlling unit 13 resumes the playback of the video content with the time immediately after the stop time written in the work area 14 as the start time of the next playback operation.

The work area 14 stores the GUI screen generated  
15 by the GUI generating unit 12, and the playback history and array H of each set of video content. The playback history referred to here is made up of combinations of start times and stop times. Array H is used to store elapsed times with intervals  $\Delta t$  between the start and  
20 stop times of each combination. Two arrays shown in FIG. 2B both have  $N$  elements, but this is merely one example used for purposes of illustration. The number of elements of array H changes depending on the progress of playback. The work area 14 shown in FIG. 2B is based  
25 on an example where video content 1 to video content 3

are recorded on the DVD 100 and three playback operations have already been performed on video content 1 and one playback operation on video content 2. Accordingly, a combination of start and stop times of the first playback operation, a combination of start and stop times of the second playback operation, and a combination of start and stop times of the third playback operation are stored in the work area 14 as the playback history of video content 1. Also, a combination of start and stop times of the first playback operation is stored in the work area 14 as the playback history of video content 2, separately from the playback history of video content 1. Thus, whenever a playback operation of video content is performed, a combination of start and stop times of that playback operation is added to the playback history of the video content in the work area 14.

The GUI updating unit 15 updates the GUI screen and has the television 101 display the updated GUI screen, after the playback controlling unit 13 performs a playback operation on video content. This update is carried out as follows. Pieces of picture data are chosen from a part of the video content between a start time and a stop time of the playback operation (such a part is hereafter referred to as a "viewed part"). Then thumbnail pictures (hereafter simply referred to as



"thumbnails") obtained by reducing these pieces of picture data are added to a program navigation area corresponding to the video content. Since the pieces of picture data from which the thumbnails are generated  
5 are chosen from the viewed part, the thumbnails displayed in the program navigation area vary depending on the progress of playback of the video content. In FIG. 3, the thumbnail area 302 of the program navigation area 300 can contain ten thumbnails at the maximum. However,  
10 if only 20% of the video content has been played back, only two thumbnails are placed in the thumbnail area 302. If 50% of the video content has been played back, five thumbnails are placed in the thumbnail area 302. If the video content has not been played back at all, only one  
15 thumbnail showing the first image of the video content is placed in the thumbnail area 302. Thus, the number of thumbnails changes depending on the progress of playback. This enables the user to instantly know to what extent the playback of the video content has  
20 progressed.

The thumbnail generating unit 16 is included in the GUI updating unit 15. The thumbnail generating unit 16 chooses the pieces of picture data that belong to the viewed part of the video content according to the start  
25 time and stop time of the playback operation, and

generates the thumbnails of these pieces of picture data. Having done so, the thumbnail generating unit 16 places the thumbnails in the program navigation area. In FIG. 2B, arrows py1, py2, and py3 represent the processing  
5 performed by the thumbnail generating unit 16. In more detail, the thumbnail generating unit 16 has the MPEG decoder 4 read the pieces of picture data in the viewed part from the DVD 100 and decode them. Once uncompressed pieces of picture data have been obtained in the frame  
10 memories 8a-8c as a result of the decoding, the thumbnail generating unit 16 reads the pieces of picture data from the frame memories 8a-8c and stores them in the work area 14 (py1). The thumbnail generating unit 16 then reduces these pieces of picture data one by one in the work area  
15 14, thereby obtaining the thumbnails (py2). The thumbnail generating unit 16 finally places the thumbnails in the thumbnail area of the program navigation area on the GUI screen (py3).

In this embodiment, pieces of picture data are  
20 chosen from a viewed part in the following manner. First, time interval  $\Delta t$  when  $N$  pieces of picture data at the maximum are chosen from the whole content is calculated from Equation 1.

25 
$$\Delta t = (\text{time length of whole content}) / N$$

..... (Equation 1)

Also, ratio  $\alpha$  of the viewed part to the whole content is calculated from Equation 2.

5

$$\alpha = (\text{time length of viewed part}) / (\text{time length of whole content})$$

..... (Equation 2)

10  $\Delta t$  in Equation 1 is equal to a time interval when  $\alpha N$  pieces of picture data are chosen from the viewed part. This is clear from Equation 3.

$$\begin{aligned} \Delta t &= (\text{time length of whole content}) / N \\ &= ((\text{time length of whole content}) \times \alpha) / (\alpha N) \\ &= (\text{time length of viewed part}) / (\alpha N) \end{aligned}$$

15 ..... (Equation 3)

Therefore, by choosing pieces of picture data with  
20 time intervals  $\Delta t$  from the viewed part,  $\alpha N$  pieces of picture data can be chosen.

FIG. 4A is a flowchart of a main routine in the microcomputer system 11. In the drawing, steps with vertical bars "|" (such as steps S1, S7, and S8) each  
25 call a subroutine.

The GUI generating unit 12 displays program navigation areas each of which visually expresses video content recorded on the DVD 100 (S1). The GUI generating unit 12 sets a program navigation area corresponding to  
5 the oldest recorded video content on the DVD 100, in the focus state (S2).

Following this, the GUI generating unit 12 executes a loop of steps S3 and S4. This loop waits for the user to press an arrow key (S3) or the ENTER key (S4) on the  
10 remote control 102. When the user presses an arrow key, the GUI generating unit 12 sets a program navigation area indicated by the pressed arrow key in the focus state (S5). Here, the remote control 102 has two arrow keys, namely, the UP key and the DOWN key. If the user presses  
15 the DOWN key, the GUI generating unit 12 returns the program navigation area which is currently in the focus state, to the normal state. The GUI generating unit 12 then sets a program navigation area which is situated below, in the focus state. If the user presses the UP  
20 key, on the other hand, the GUI generating unit 12 returns the program navigation area which is currently in the focus state, to the normal state. The GUI generating unit 12 then sets a program navigation area which is situated above, in the focus state.

25 When the user presses the ENTER key, the GUI

generating unit 12 sets the program navigation area which is currently in the focus state, in the active state. Having done so, the GUI generating unit 12 determines video content corresponding to the program navigation  
5 area in the active state, as playback target video content  $x$  (S6). Once video content  $x$  has been determined, the playback controlling unit 13 performs the  $y$ th playback operation on video content  $x$  (S7). Here,  $y$  is a variable showing the number of playback operations  
10 performed on video content  $x$ , and is incremented by 1 each time a playback operation is performed on video content  $x$ . After the  $y$ th playback operation ends, the GUI updating unit 15 updates the GUI screen according to the playback history of the  $y$ th playback operation  
15 (S8).

FIG. 4B is a flowchart of a subroutine called in step S1, and shows processing performed by the GUI generating unit 12.

The GUI generating unit 12 generates  $M$  program  
20 navigation areas which each have a thumbnail area capable of containing  $N$  thumbnails, on the GUI screen (S9). The GUI generating unit 12 places a recording date and time, channel, and title of video content in the index area of each program navigation area (S10). The GUI  
25 generating unit 12 also places a thumbnail of the first

picture data of video content in the thumbnail area of each program navigation area (S11). The GUI generating unit 12 then returns to the main routine shown in FIG. 4A.

5           FIG. 5 is a flowchart of a subroutine called in step S7, and shows processing performed by the playback controlling unit 13.

          The playback controlling unit 13 judges whether a playback history of video content x exists in the work  
10   area 14 (S12).

          If a playback history does not exist in the work area 14, the playback controlling unit 13 resets variable y to 1 (S13), and sets the beginning of video content x as the start position of the yth playback operation  
15   (S14). The playback controlling unit 13 then instructs the MPEG decoder 4 and the DVD drive 1 to start playing video content x from the start position (S15). Hence video content x is played from the beginning.

          If a playback history of video content x exists in  
20   the work area 14, the playback controlling unit 13 acquires the stop time of the last playback history of video content x from the work area 14 (S16). The playback controlling unit 13 then sets a point immediately after the acquired stop time as the start  
25   position of the yth playback operation (S17), before

advancing to step S15. Since the start position is immediately after the stop time of the last playback operation, resume playback is carried out in this case.

Following this, the playback controlling unit 13  
5 waits for a PTS output from the order controlling unit 9 (S18). When a PTS is output, the playback controlling unit 13 acquires the PTS, and stores it in the work area 14 as the start time of the yth playback operation (S19).

The playback controlling unit 13 then waits for the  
10 occurrence of an event (S20 and S21). Here, the playback controlling unit 13 waits for either video content x to end (S20) or the user to press the STOP key on the remote control 102 (S21). If video content x ends (S20:YES), the playback controlling unit 13 advances to step S23.  
15 If the user presses the STOP key on the remote control 102 (S21:YES), the playback controlling unit 13 stops the MPEG decoder 4 and the DVD drive 1 (S22), before advancing to step S23.

The playback controlling unit 13 acquires a PTS  
20 from the order controlling unit 9 (S23), and sets it as the stop time of the yth playback operation (S24). The playback controlling unit 13 stores the combination of the start and stop times in the work area 14, as the playback history of the yth playback operation on video  
25 content x (S25). After this, the processing returns to

the main routine shown FIG. 4A.

In step S14 in FIG. 5, the beginning of video content  $x$  is set as the start position. However, if video content  $x$  contains a chapter or a mark that can be located, such a chapter or mark may instead be set as the start position. Also, if time search playback that starts playback at a time designated by the user is possible, such a time designated by the user may be set as the start position.

FIGS. 6A and 6B are a flowchart of a subroutine called in step S8, and show processing performed by the GUI updating unit 15 and the thumbnail generating unit 16.

The GUI updating unit 15 checks variable  $y$ , to judge whether the number of playback operations performed on video content  $x$  is one or more (S31).

If the number of playback operations is one, the GUI updating unit 15 finds  $\Delta t$  by dividing the total playback time length of video content  $x$  by upper limit  $N$  to the number of displayable thumbnails (S32). The GUI updating unit 15 then initializes array  $H$  of video content  $x$  (S33). The GUI updating unit 15 resets variable  $k$  which is the index of array  $H$ , to 0 (S34). The GUI updating unit 15 then advances to steps S35-S38. In steps S35-S38, elapsed times with intervals  $\Delta t$



in the viewed part of video content  $x$  are stored in array  $H$  of video content  $x$ . Here, elapsed time "0sec" is stored in array element  $H[0]$  at the beginning of array  $H$ .

5        Steps S35-S38 repeat a loop of adding  $\Delta t$  to the  $k$ th array element  $H[k]$  and storing the sum in the  $(k+1)$ th array element  $H[k+1]$  (S37). Variable  $k$  is incremented by 1 (S38). This loop ends when the sum of the  $k$ th array element  $H[k]$  and  $\Delta t$  is judged as exceeding the stop time  
10 of the  $y$ th playback operation (S36:YES). In other words, the loop is repeated until the sum of the  $k$ th array element  $H[k]$  and  $\Delta t$  exceeds the stop time of the  $y$ th playback operation.

When the judgement "YES" is given in step S36, the  
15 value of  $k$  is set as the last number (S53), before advancing to step S41.

If the number of playback operations of video content  $x$  is more than one (S31:NO), it means array  $H$  of video content  $x$  already exists. Accordingly, the GUI  
20 updating unit 15 adds 1 to the last number of array  $H$ , and assigns the sum to variable  $ks$  (S39). The GUI updating unit 15 further assigns  $ks$  to variable  $k$  (S40). The GUI updating unit 15 then performs steps S35-S38. As a result, elapsed times with intervals  $\Delta t$  from the  
25 start time to stop time of the  $y$ th playback operation

are added to array H.

Steps S41-S51 show processing of placing  
thumbnails on the GUI screen by the thumbnail generating  
unit 16. Before explaining this processing, a layout  
5 of thumbnails in a thumbnail area is explained first.  
In the thumbnail area, the thumbnails are placed in  
matrix. Here, the location of a thumbnail in the matrix  
is expressed as the  $i$ th column and the  $j$ th row where  $i$   
and  $j$  are variables. In FIG. 3, the values of  $i$  and  $j$   
10 are enclosed in parentheses to designate the display  
location of each thumbnail in the thumbnail area 302.

The thumbnail placement of steps S41-S51 is  
explained below. The thumbnail generating unit 16  
checks variable  $y$ , to judge whether the number of  
15 playback operations performed on video content X is one  
or more (S41). If the number of playback operations is  
one, the thumbnail generating unit 16 sets  $j$  and  $k$  at  
1 and sets  $i$  at 2 (S42).

After this, the thumbnail generating unit 16 reads  
20 a piece of picture data of video content x corresponding  
to array element  $H[k]$  (S43). The thumbnail generating  
unit 16 generates a thumbnail of the read piece of picture  
data (S44), and displays the thumbnail in the  $i$ th column  
and the  $j$ th row (S45). Variable  $i$  which specifies the  
25 column coordinate is incremented by 1 (S48). Steps

S43-S46 are repeated until variable *i* exceeds the horizontal length of the thumbnail area (S49). In this way, each thumbnail is placed in the thumbnail area in the horizontal direction.

5        If variable *i* exceeds the horizontal length, variable *j* is incremented by 1 and variable *i* is reset to 1 (S50). After step S51, the processing returns to step S43.

10        As a result of incrementing variable *j*, the display location of a thumbnail shifts to the left end of the second row in the thumbnail area. After this, the loop of steps S43-S51 is repeated to place each thumbnail in the second row of the thumbnail area in the horizontal direction.

15        This loop is repeated until variable *i* exceeds the horizontal length of the thumbnail area (S49:YES) and variable *j* exceeds the vertical length of the thumbnail area (S51:YES). If variable *k* exceeds the number of array elements (S47:YES), the processing ends  
20        regardless of the values of *i* and *j*. Thus, if video content *x* has been played only up to some midpoint, part of the thumbnail area is left unoccupied by thumbnails. The processing then returns to the main routine shown in FIG. 4A.

25        If the number of playback operations is more than

one (S41:NO), the thumbnail generating unit 16 sets  $i$  and  $j$  at values immediately after the last thumbnail in the thumbnail area, and assigns  $ks$  to  $k$ . Here,  $ks$  is the value which was calculated in step S39 by adding 1 to the last number of array H of video content  $x$ . By such setting  $i$ ,  $j$ , and  $k$ , thumbnails corresponding to the  $y$ th playback operation are sequentially placed following the existing thumbnails in the thumbnail area.

Though  $\Delta t$  is calculated using the above equation,  $\Delta t$  may instead be a predetermined time interval, such as one minute or two minutes. In this case, the number of thumbnails displayed in the thumbnail area indicates the progress of playback not by ratio but by time.

The procedures shown by these flowcharts are explained in greater detail below, using specific examples of FIGS. 7 to 9.

Suppose three sets of video content that are video content 1, video content 2, and video content 3 are recorded on the DVD 100, which have not been played back at all. This being the case, step S1 is performed to display program navigation areas corresponding to video content 1 to 3 on the GUI screen. FIG. 7 shows the resulting display. In the drawing, a program navigation area corresponding to each of video content 1 to 3 is displayed on the GUI screen. A title, recording date

and time, and channel of the corresponding video content are provided in the index area of each program navigation area. Also, a thumbnail of the first piece of picture data of the corresponding video content is provided in the thumbnail area of each program navigation area.

5 the thumbnail area of each program navigation area. Suppose video content 1 is determined as playback target video content x as a result of user operations on this GUI screen. Video content 1 has a total playback time length of 3000sec (PM8:00-PM8:50). This being so,

10 suppose a playback operation starts at the beginning of video content 1 (at the 0sec point) and stops after 1240 seconds (at the 1240sec point). Then step S8 is performed to update the program navigation area of video content 1. In detail, four pieces of picture data with

15 intervals of 300sec are chosen from the part of video content 1 between the 0sec point where the playback operation started and the 1240sec point where the playback operation stopped. Following this, thumbnails of these pieces of picture data are placed in the

20 thumbnail area of the program navigation area of video content 1. FIG. 8 shows how the GUI screen is updated when video content 1 has been played from the beginning up to the 1240sec point. As illustrated, a thumbnail of a piece of picture data at the 300sec point, a

25 thumbnail of a piece of picture data at the 600sec point,

a thumbnail of a piece of picture data at the 900sec point,  
and a thumbnail of a piece of picture data at the 1200sec  
point are placed in the thumbnail area of video content  
1, in addition to a thumbnail of a piece of picture data  
5 at the 0sec point. This display enables the user to  
recall the contents of the viewed part.

This update is done according to the processing  
shown in FIGS. 6A and 6B. In step S32, the total playback  
time length of video content 1 (3000sec) is divided by  
10 the upper limit to the number of displayable thumbnails  
(10), thereby obtaining  $\Delta t = 300\text{sec}$ . Also, array element  
 $H[0]$  of video content 1 is set at 0sec which is the  
beginning of video content 1. Since array element  $H[0]$   
is 0sec, array element  $H[1]$  is set as  
15  $H[1] = H[0] + \Delta t = 0 + 300 = 300\text{sec}$  as a result of the first  
execution of step S37 in the loop of steps S35-S38. Next,  
array element  $H[2]$  is set as  
 $H[2] = H[1] + \Delta t = 300 + 300 = 600\text{sec}$  as a result of the second  
execution of step S37 in the loop of steps S35-S38. In  
20 the same manner, array element  $H[3]$  is set as  
 $H[3] = H[2] + \Delta t = 600 + 300 = 900\text{sec}$  as a result of the third  
execution of step S37, and array element  $H[4]$  is set as  
 $H[4] = H[3] + \Delta t = 900 + 300 = 1200\text{sec}$  as a result of the fourth  
execution of step S37.

25 After this,  $H[4] + \Delta t = 1200 + 300 = 1500\text{sec}$  is

calculated in step S36. This  $H[k] + \Delta t$  exceeds the stop time of the  $y$ th playback operation of video content 1, that is, 1240sec. Accordingly, the judgement "YES" is given in step S36 to exit from the loop of step S35-  
5 S38.

In this way, the array elements of video content 1 are set such that  $H[0]=0$ ,  $H[1]=300$ ,  $H[2]=600$ ,  $H[3]=900$ , and  $H[4]=1200$ . Accordingly, the thumbnail generating unit 16 chooses the pieces of picture data which are  
10 present respectively at the 300sec point, the 600sec point, the 900sec point, and the 1200sec point, and places the thumbnails of these pieces of picture data in the thumbnail area of the program navigation area, according to the procedure shown in FIG. 6B. FIG. 9 is  
15 a representation of a process of choosing these pieces of picture data and reducing them. In the drawing, the piece of picture data at the 0sec point has already been reduced and placed at (1,1) in the thumbnail area. In addition to this, the piece of picture data at the 300sec  
20 point is reduced and placed at (2,1) in the thumbnail area. Also, the piece of picture data at the 600sec point is reduced and placed at (3,1) in the thumbnail area, the piece of picture data at the 900sec point is reduced and placed at (4,1) in the thumbnail area, and  
25 the piece of picture data at the 1200sec point is reduce

and placed at (5,1) in the thumbnail area. Hence the display shown in FIG. 8 is obtained.

Suppose the user resumes the playback of video content 1 after a certain period of time. As one example, the second playback operation starts immediately after the 1240sec point and stops at the 2200sec point. Accordingly, step S8 is performed to update the GUI screen. In detail, three pieces of picture data with intervals of 300sec are chosen from the part of video content between the 1240sec point where the playback operation started and the 2200sec point where the playback operation stopped. Then thumbnails of these pieces of picture data are placed in the thumbnail area of the program navigation area of video content 1.

FIG. 10 shows how the GUI screen is updated when video content 1 has further been played from the 1240sec point up to the 2200sec point. A thumbnail of a piece of picture data at the 1500sec point, a thumbnail of a piece of picture data at the 1800sec point, and a thumbnail of a piece of picture data at the 2100sec point are placed in the thumbnail area of the program navigation area of video content 1.

Suppose the user resumes the playback of video content 1 and further plays back video content 2, after a certain period of time. As one example, the third



playback operation of video content 1 starts at immediately after the 2200sec point and stops at the 3000sec point, and then video content 2 is played from the beginning (the 0sec point) up to the 1000sec point.

5 Accordingly, step S8 is performed to update the GUI screen. In detail, two pieces of picture data with intervals of 300sec are chosen from the part of video content 1 between the 2200sec point where the playback operation started and the 3000sec point where video  
10 content 1 ended. Then thumbnails of these pieces of picture data are placed in the thumbnail area of the program navigation area of video content 1. Also, three pieces of picture data with intervals of 300sec are chosen from the part of video content 2 between the 0sec  
15 point where the playback operation started and the 1000sec point where the playback operation stopped. Then thumbnails of these pieces of picture data are placed in the thumbnail area of the program navigation area of video content 2.

20 FIG. 11 shows how the GUI screen is updated when video content 1 has been played to the end and video content 2 has been played from the beginning up to the 1000sec point. As illustrated, a thumbnail of a piece of picture data at the 2400sec point and a thumbnail of  
25 a piece of picture data at the 2700sec point are placed

in the thumbnail area of the program navigation area of video content 1. Also, a thumbnail of a piece of picture data at the 300sec point, a thumbnail of a piece of picture data at the 600sec point, and a thumbnail of a piece of picture data at the 900sec point are placed in the thumbnail area of the program navigation area of video content 2, in addition to a thumbnail of a piece of picture data at the 0sec point.

Suppose video content 1 to 3 have all been completely played after all. FIG. 12 shows how the GUI screen is updated when all of video content 1 to 3 have been completely played. As illustrated, the thumbnail areas of the program navigation areas of video content 1 to 3 are completely occupied with thumbnails.

Once the thumbnail areas of the program navigation areas have become full as shown in FIG. 12, the GUI screen may be returned to the state shown in FIG. 7, to allow the user to view these video content again with a fresh mind.

According to this embodiment, pieces of picture data are chosen from a part of video content between a playback start time and a playback stop time and thumbnails of these pieces of picture data are displayed on the GUI screen. This helps the user instantly recall the contents of the viewed part, thereby facilitating

further viewing.

This embodiment has the following effects when compared with a technique of choosing pieces of picture data from the whole video content and displaying  
5 thumbnails of these pieces of picture data on a GUI screen. When viewing video content such as a drama series, the user enjoys the story development while predicting an ending or climax such as "Who committed the crime?" or "Are they going to get married?". Therefore, when  
10 pieces of picture data are chosen not only from the viewed part but from the whole video content and thumbnails of these pieces of picture data are displayed, the user finds out the ending or climax even if he or she does not want to. This spoils the fun of watching the drama  
15 series to the end. According to this embodiment, however, pieces of picture data are chosen only from the viewed part between the playback start time and the playback stop time. Therefore, the ending or climax which the user has not yet watched is not shown on the  
20 GUI screen, with it being possible to keep the fun of watching the drama series to the end. Thus, by displaying thumbnails of only the viewed part and not displaying thumbnails of the unviewed part, it is possible to bring about the user's fresh memory of the  
25 contents of the viewed part, without spoiling his or her

fun of watching the whole content.

Furthermore, this embodiment has the following effects when compared with a technique of displaying thumbnails of pieces of picture data which are located  
5 at the playback start time and playback stop time on the GUI screen. Each episode of a drama series usually begins with a typical opening theme song or sponsor announcement. Displaying a thumbnail of such part does not much help the user recall the contents of the  
10 previously viewed episode. The same applies to the case of displaying a thumbnail of a piece of picture data corresponding to the playback stop time. Usually, the user stops playback not at a high point of the episode but a while after the high point. Displaying a thumbnail  
15 of such insignificant part of the episode does not much help the user to recall the contents of the previously viewed episode. According to this embodiment, however, several pieces of picture data are chosen between the playback start time and the playback stop time and  
20 thumbnails of these pieces of picture data are displayed on the GUI screen. This enables the user to regain the fresh memory of the previously viewed episode. Thus, this embodiment delivers effects that are out of the reach of the technique of merely displaying the  
25 thumbnails corresponding to the playback start time and

stop time on the GUI screen.

The following are two example modifications to the first embodiment.

(First Modification to the First Embodiment)

5        In the first embodiment, to indicate the progress of playback of video content by the number of thumbnails, thumbnails of pieces of picture data between the start time of the first playback operation and the stop time of the  $y$ th playback operation are placed together in a program navigation area of the video content. As an  
10        alternative, only thumbnails of pieces of picture data between the start time of the  $y$ th playback operation and the stop time of the  $y$ th playback operation may be placed in the program navigation area, by writing them over  
15        existing thumbnails.

      In more detail, first the existing thumbnails (thumbnails between the start time of the first playback operation and the stop time of the  $(y-1)$ th playback operation) are deleted from the GUI screen. Then  $N$   
20        pieces of picture data are chosen from the part of the video content between the start time of the  $y$ th playback operation and the stop time of the  $y$ th playback operation, and  $N$  thumbnails of the  $N$  pieces of picture data are placed in the program navigation area. This enables the  
25        contents of the viewed part of the  $y$ th playback operation

to be presented with a greater number of thumbnails.  
Hence the user can recall the contents of the viewed part  
more clearly.

Suppose a playback operation has been performed  
5 from the 0sec point to the 1240sec point, with an upper  
limit for the number of displayable thumbnails being ten  
(like the example of FIG. 8). In this case, the viewed  
part of 1240 seconds in length is expressed using ten  
thumbnails, so that  $\Delta t = 124\text{sec} (= 1240/10)$ . Accordingly,  
10 pieces of picture data are chosen with intervals of  
124sec from the viewed part, and thumbnails of the pieces  
of picture data are placed in the program navigation area.  
In the example of FIG. 8,  $\Delta t$  is 5min ( $= 300\text{sec}$ ), and  
therefore the viewed part is expressed using five  
15 thumbnails. In this modification, on the other hand,  
 $\Delta t$  is about 2min ( $= 124\text{sec}$ ), and therefore the viewed part  
can be expressed using ten thumbnails. This enables the  
user to recall the contents of the viewed part more  
clearly.

20 (Second Modification to the First Embodiment)

In this second modification, if the DVD 100 is  
recordable, the playback history and array H of each set  
of video content stored in the work area 14 are written  
onto the DVD 100. In this way, even after the playback  
25 apparatus is shut down or the DVD 100 is changed to

another, the playback history and array H of each set of video content recorded on the DVD 100 can be used. In this case, the DVD 100 need be of such a type that supports writing from the user.

5           The playback apparatus of this second modification is further equipped with a tuner and an MPEG encoder.

          The tuner demodulates a television broadcast signal, and outputs a video signal and an audio signal to the MPEG encoder.

10           The MPEG encoder encodes the video signal and the audio signal to obtain a VOB.

          The DVD drive 1 writes the VOB onto the DVD 100.

          With the provision of the tuner and the MPEG encoder, the playback apparatus has a function of recording  
15   broadcast video content.

          The playback controlling unit 13 plays back video content recorded on the DVD 100. In addition, the playback controlling unit 13 performs the following operation. In step S7 in FIG. 4A, immediately after  
20   performing the yth playback operation on video content x, the playback controlling unit 13 writes the playback history and array H of each set of video content in the work area 14, onto the DVD 100. In so doing, even when  
25   the DVD 100 is changed to another, the playback history and array H of each set of video content recorded on the

DVD 100 are retained on the DVD 100.

Since the playback history and array H of each set of video content are retained on the DVD 100, the playback controlling unit 13 reads the playback history and array H from the DVD 100 and writes them in the RAM 11c, prior to the GUI update of step S8. Thus, the GUI screen is updated based on the playback history and array H retained on the DVD 100.

In this case, GUI update is performed not only after a playback operation is performed in step S7 but also when the DVD 100 is changed to another DVD. Prior to this update, the playback controlling unit 13 reads the playback history and the array H from the DVD 100 and writes them into the RAM 11c. Therefore, even if the DVD 100 is replaced with another DVD in the playback apparatus, the user can recall the contents of the viewed part when later the DVD 100 is reinserted to the playback apparatus and played back.

If the DVD 100 is a multiuser disc, it is desirable to record the playback history and array H as personal information of each individual user. This enables each individual user to clearly recall the contents of the part which he or she has previously viewed.

(Second Embodiment)



In the first embodiment, a plurality of thumbnails up to  $N$  thumbnails at the maximum are displayed for each set of video content. However, if a larger number of sets of video content are recorded on the DVD 100, a display area for each set of video content becomes smaller, and eventually it becomes impossible to display  $N$  thumbnails in a thumbnail area of each set of video content. This problem might be solved by reducing the size of each thumbnail, but this makes it hard for the user to understand the display contents. Considering the resolutions of home televisions, it is not desirable to reduce the thumbnail size too much. In view of this problem, the GUI generating unit 12 of the second embodiment uses a layout of FIG. 13 instead of the layout of FIG. 3 if the number of sets of video content increases.

In FIG. 3, each thumbnail area is large enough to display ten thumbnails. In FIG. 13, on the other hand, each thumbnail area is small and can only display one thumbnail. Meanwhile, there are nine thumbnail areas for nine sets of video content in FIG. 13.

Suppose video content 1 among the nine sets of video content has been played from the 0sec point up to the 1240sec point, like the example of FIG. 8. In such a case, the corresponding thumbnails are displayed one

after another like a slide show in a thumbnail area of a program navigation area of video content 1. FIGS. 14A to 14F show how the thumbnails are displayed like slides. In FIG. 14A, the thumbnail of the piece of picture data at the 0sec point is displayed in the thumbnail area of video content 1. In FIG. 14B, the display has been switched to the thumbnail of the piece of picture data at the 300sec point. Likewise, the display has been switched to the thumbnail of the piece of picture data at the 600sec point in FIG. 14C, the thumbnail of the piece of picture data at the 900sec point in FIG. 14D, and the thumbnail of the piece of picture data at the 1200sec point in FIG. 14E. After this, the display has returned to the thumbnail of the piece of picture data at the 0sec point in FIG. 14F. Thus, a plurality of thumbnails for one set of video content are displayed one after another like slides in a thumbnail area of that video content in this embodiment. Here, if the other sets of video content, i.e. video content 2 to 9, have not been played at all, a thumbnail of the first picture remains in a thumbnail area of a program navigation area of each of these video content 2 to 9.

FIGS. 15A and 15B are a flowchart of a main routine in the second embodiment. FIGS. 15A and 15B correspond to FIG. 4A in the first embodiment, but differ from FIG.

4A in that (i) step S1 has been replaced with step S60,  
(ii) step S61 has been added between steps S2 and S3,  
(iii) steps S62-64 have been added to the loop of steps  
S3-S4, and (iv) steps S65-S66 have been added between  
5 steps S7-S8.

The most important difference lies in the addition  
of steps S61, S62, and S63. These steps use variables  
 $p$  and  $kp$ .

Variable  $p$  identifies one of  $M$  sets of video content  
10 recorded on the DVD 100. When  $M$  sets of video content  
are recorded on the DVD 100, variable  $p$  identifies one  
of video content 1 to  $M$ .

Variable  $kp$  identifies an array element of video  
content  $p$ . Since variable  $p$  identifies each of video  
15 content 1, 2, 3, 4, ... ,  $M$ , there are  $M$  variables  $kp$  that  
are  $k1$ ,  $k2$ ,  $k3$ ,  $k4$ , ... ,  $kM$ . Variable  $k1$  identifies an  
array element of video content 1. Variable  $k2$   
identifies an array element of video content 2.  
Variable  $k3$  identifies an array element of video content  
20 3. Variable  $k4$  identifies an array element of video  
content 4.

Through the use of such variables  $p$  and  $kp$ , steps  
S61 and S63 are performed in the following way.

Variables  $k1$ ,  $k2$ ,  $k3$ ,  $k4$ , ... ,  $kM$  corresponding to video  
25 content 1, 2, 3, 4, ... ,  $M$  recorded on the DVD 100 are

all reset to 0 (S61). After this, a loop of steps S3-S4 and S63-S64 is repeated. This loop waits for the user's selection of video content  $x$ , as in the first embodiment. Also, thumbnails corresponding to array elements specified by variables  $k1, k2, k3, \dots, kM$  are placed simultaneously in the program navigation areas of video content 1, 2, 3,  $\dots$ ,  $M$  respectively (S63), and then variables  $k1, k2, k3, \dots, kM$  are all incremented by 1 (S64).

Each time the loop is repeated, new thumbnails specified by incremented variables  $k1, k2, k3, \dots, kM$  are placed in the program navigation areas of video content 1, 2, 3,  $\dots$ ,  $M$  respectively (S63). Thus, the thumbnails of all program navigation areas are updated each time the loop is repeated. In this way, while waiting for the user's selection, each program navigation area is constantly updated to display a new thumbnail. Though only one thumbnail at a time can be displayed in the thumbnail area of each program navigation area, the display contents of the thumbnail area are constantly updated while waiting for the user's selection. Therefore, even if the thumbnail area is small, the user can clearly recall the contents of the previously viewed part.

The remaining parts of the flowchart shown in FIG.

15 are explained below. One of the layout of FIG. 3 and the layout of FIG. 13 is selected, and the selection result is set in a flag. Having done so, the program navigation areas are displayed in the selected layout  
5 (S60). When the flag is 0, the layout of FIG. 3 is used. When the flag is 1, the layout of FIG. 13 is used. Following this, one set of video content is set in the focus state (S2), and the loop of steps S3-S4 and S62-S64 is performed.

10 Step S62 is provided to maintain compatibility with the main routine of FIG. 4A. If the flag is 0 (S62:NO), steps S3-S4 are performed to wait for the user's selection of video content x. If the flag is 1 (S62:YES), steps S3-S4 and S63-S64 are performed to wait for the  
15 user's selection of video content x.

As described above, steps S63-S64 are performed to update the thumbnails of all program navigation areas simultaneously. Accordingly, if the flag is 1, new thumbnails are displayed in turn in the program  
20 navigation area of each set of video content. If the user presses the ENTER key to determine video content x, the playback controlling unit 13 plays video content x (S6 and S7). Then the flag is checked (S65).

If the flag is 0, the GUI updating unit 15 updates  
25 the GUI screen according to the playback history of the

yth playback operation (S8). If the flag is 1, the GUI updating unit 15 only adds array elements according to the playback history of the yth playback operation (S66). In step S8, the GUI updating unit 15 adds the array  
5 elements and then updates the program navigation areas according to the added array elements. In step S66, on the other hand, the GUI updating unit 15 only adds the array elements and does not update the program navigation areas. When the layout of FIG. 13 is used, the  
10 thumbnails are updated in steps S63 and S64, so that there is no need to update the thumbnails in step S66.

FIG. 16 is a flowchart of a subroutine called in step S60, and shows processing of the GUI generating unit 12 in the second embodiment. FIG. 16 corresponds to FIG.  
15 4B in the first embodiment, but differs from FIG. 4B in that steps S67 and S68 have been added. The following explanation focuses on this difference. The GUI generating unit 12 multiplies  $M$  by  $N$  where  $M$  is the number of sets of video content and  $N$  is the upper limit to the  
20 number of displayable thumbnails for each set of video content (S67). If the product is no greater than the total number of displayable thumbnails in one GUI screen, the GUI generating unit 12 advances to steps S9-S11. These steps are similar to those in FIG. 4B. Here, the  
25 GUI generating unit 12 sets the flag at 0, to select the

layout of FIG. 3. If the product exceeds the total number of displayable thumbnails, the GUI generating unit 12 generates *M* program navigation areas each having a thumbnail area capable of containing only one thumbnail,  
5 on the GUI screen. The GUI generating unit 12 also sets the flag at 1 (S68). Following this, the GUI generating unit 12 advances to steps S10 and S11 to display the program navigation areas, before returning to the main routine of FIG. 15.

10 FIG. 17 is a flowchart of a subroutine called in step S63, and shows processing of the GUI updating unit 15 and the thumbnail generating unit 16 in the second embodiment.

This flowchart includes a loop (S71 and S72) which  
15 repeats steps S74-S79 for each set of video content. This loop is provided to update all program navigation areas each time the loop of steps S3-S4 and S62-S64 is performed. Suppose video content *p* is video content that is subjected to the loop of steps S71 and S72. The  
20 thumbnail generating unit 16 judges whether array *H* of video content *p* has at least two array elements (S74). If so (S74:YES), the thumbnail generating unit 16 judges whether variable *kp* exceeds the number of array elements (S75). If variable *kp* does not exceed the number of  
25 array elements (S75:NO), the thumbnail generating unit

16 reads a piece of picture data of video content  $p$  which is specified by array element  $H[kp]$  (S76), and generates a thumbnail of the piece of picture data (S77). The thumbnail generating unit 16 then displays the thumbnail  
5 in a thumbnail area of video content  $p$  (S78). This is repeated for each set of video content, before returning to the main routine of FIG. 15. As a result, a thumbnail of a piece of picture data which is specified by variable  $kp$  is displayed for every set of video content on the  
10 GUI screen. Step S79 is provided to reset variable  $kp$  to 0 when variable  $kp$  exceeds the number of array elements (S75:YES), before the thumbnail display operation. Also, if the number of array elements is smaller than two (S74:NO), steps S75-S78 are skipped to advance to  
15 process the next content.

Thus, the slide display of thumbnails for each set of video content is carried out until the number of array elements is exceeded.

FIG. 18 is a flowchart of a subroutine called in  
20 step S66, and shows processing of the GUI updating unit 15 in the second embodiment. The flowchart of FIG. 18 is made up of steps S31-S38 shown in FIG. 6. When the  $y$ th playback operation is performed on video content  $x$ , the GUI updating unit 15 chooses pieces of picture data  
25 with intervals of  $\Delta t$  from the part of video content  $x$



between the start time and stop time of the  $y$ th playback operation, and adds them to array H of video content  $x$ .

The procedures performed in this embodiment are explained using specific examples below. Suppose nine  
5 sets of video content that are video content 1, 2, 3, ... , 9 are recorded on the DVD 100, with array elements of these video content being specified by variables  $k_1$ ,  $k_2$ ,  $k_3$ , ... ,  $k_9$  ( $p=1, 2, 3, \dots, 9$ ). This being the case, step S61 is performed to reset  $k_1$ ,  $k_2$ ,  $k_3$ , ... ,  $k_9$  all  
10 to 0. As a result, the 0th array elements are specified in arrays H of video content 1, 2, 3, ... , 9. Subsequently, step S63 is performed to place thumbnails corresponding to the 0th array elements in the program navigation areas of video content 1, 2, 3, ... , 9.

15 Then step S64 is performed to increment variables  $k_1$ ,  $k_2$ ,  $k_3$ , ... ,  $k_9$  by 1, before returning to step S3. Since  $k_1$ ,  $k_2$ ,  $k_3$ , ... ,  $k_9$  become 1, the first array elements are specified in arrays H of video content 1, 2, 3, ... , 9. In step S63, thumbnails corresponding to the first  
20 array elements are placed in the program navigation areas of video content 1, 2, 3, ... , 9. The same processing is repeated to place thumbnails corresponding to the second, third, and fourth array elements one after another in the program navigation areas of video content  
25 1, 2, 3, ... 9.

As described above, this embodiment has the following construction. Suppose  $N$  denotes the number of displayable thumbnails for each set of video content, and  $M$  denotes the number of sets of video content. If  $M \cdot N$  thumbnails can be contained within one GUI screen, thumbnails of each set of video content are simultaneously displayed in list form. If  $M \cdot N$  thumbnails cannot be contained within one GUI screen, thumbnails of each set of video content are displayed one after another like slides. With this construction, even if the total number of thumbnails  $M \cdot N$  is large, it is possible to display these thumbnails. Hence the user can understand the recorded contents of the DVD 100 easily even when a lot of sets of video content are recorded on the DVD 100.

Though this embodiment describes the case where the layout of FIG. 13 is used when the number of sets of video content is large, the program navigation areas may instead be provided on a plurality of pages with the layout of FIG. 3. This being so, upon receiving a page turning request, these pages are turned to display all program navigation areas. Alternatively, the program navigation areas may be provided on a plurality of pages with the layout of FIG. 13. In this case too, upon receiving a page turning request, these pages are turned

to display all program navigation areas.

(Third Embodiment)

In the first embodiment, pieces of picture data are  
5 chosen with regular intervals. In the third embodiment,  
on the other hand, pieces of picture data are chosen with  
irregular intervals.

In the first embodiment, pieces of picture data are  
chosen with regular intervals from a viewed part between  
10 a playback start time and a playback stop time, and  
thumbnails of the chosen pieces of picture data are  
displayed on the GUI screen. Therefore, the thumbnails  
have equal time intervals between themselves. In the  
third embodiment, more thumbnails are displayed near the  
15 playback stop time than near the playback start time.

To do so, the playback apparatus of the third  
embodiment performs a process of storing elapsed time  
 $T/(u \cdot v)$  after array element  $H[k]$  into array element  
 $H[k+1]$ . FIG. 19 shows how array elements  $H[0]$ ,  $H[1]$ ,  
20  $H[2]$ ,  $H[3]$  ... are determined when  $u$  is 4 and  $v$  is any of  
1 to 4. Here,  $u$  is a fixed number that satisfies  
 $N=1+2+3+4+\dots+u$ , where  $N$  is the upper limit to the number  
of displayable thumbnails in one program navigation area.  
Also,  $v$  is an integer that satisfies  $1 \leq v \leq u$ .

25 If  $v=1$ , array element  $H[1]$  is determined using time

interval  $T/(u \cdot 1)$ . If  $v=2$ , array elements  $H[2]$  and  $H[3]$  are determined using time intervals  $T/(u \cdot 2)$ . If  $v=3$ , array elements  $H[4]$ ,  $H[5]$ , and  $H[6]$  are determined using time intervals  $T/(u \cdot 3)$ . If  $v=4$ , array elements  $H[7]$ ,  $H[8]$ ,  $H[9]$ , and  $H[10]$  are determined using time intervals  $T/(u \cdot 4)$ . Variable  $v$  is smaller near the playback start time, and is larger near the playback stop time. In FIG. 19,  $w$  is a variable whose upper limit is  $u$ . To calculate the array elements in this way, step S8 in FIG. 4A is carried out according to processing shown in FIG. 20. FIG. 20 is a flowchart of a subroutine called in step S8, and shows processing of the GUI updating unit 15 and the thumbnail generating unit 16 in the third embodiment. This processing is executed after the  $y$ th playback operation of video content  $x$  has been performed and the playback history of the  $y$ th playback operation has been obtained.

The GUI updating unit 15 calculates integer  $u$  no smaller than 1, such that  $N=1+2+3+\dots+u$  (S81). The GUI updating unit 15 sets the time length from the start time of the first playback operation to the stop time of the  $y$ th playback operation as  $T$  (S82). The GUI updating unit 15 then assigns the value of  $T/u$  to  $\Delta t$  (S83), and initializes array  $H$  of video content  $x$  (S84). After this, the GUI updating unit 15 resets variable  $k$  to 0 (S85),

and variable  $v$  to 1 (S86). The GUI updating unit 15 then divides the value of  $\Delta t$  by  $v$  and sets the result as  $\Delta t$ , and also resets  $w$  to 1 (S87). The GUI updating unit 15 then repeats a loop of steps S36-S37 and S88-S89.

5        This loop repeats a process of adding  $\Delta t$  to array element  $H[k]$  and storing the sum in array element  $H[k+1]$ . In each repetition, variables  $k$  and  $w$  are incremented by 1 (S88). The loop ends when the sum of array element  $H[k]$  and  $\Delta t$  exceeds the stop time of the  $y$ th playback  
10 operation (S36:YES) or when variable  $w$  exceeds variable  $v$  (S89:YES). Variable  $v$  here is used to divide  $\Delta t (=T/u)$ . When divided by  $v$ ,  $\Delta t$  becomes  $T/(u \cdot v)$ . In other words, this loop repeats a process of storing elapsed times with intervals of  $T/(u \cdot v)$  in array  $H$  until  $w$  exceeds  $v$ .

15        When  $w$  exceeds  $v$ ,  $v$  is incremented by 1. If  $v$  is no greater than  $u$ , the processing returns to step S87. As described above, step S87 divides  $\Delta t$  by  $v$ . Which is to say, as a result of incrementing  $v$  by 1,  $\Delta t (=T/(u \cdot v))$  becomes smaller. This process of incrementing  $v$  and  
20 thereby making  $\Delta t$  smaller is repeated until  $v$  exceeds  $u$  (S91). If  $v$  exceeds  $u$ , the processing proceeds to steps S43-S51. These steps are the same as those in FIG. 6. As a result of these steps, thumbnails are displayed in accordance with the array elements of array  $H$ .

25        This processing shown in FIG. 20 is explained in

greater detail below, using a specific example shown in FIG. 21A. FIG. 21A shows how array elements  $H[0]$ ,  $H[1]$ ,  $H[2]$ ,  $H[3]$ , ... are determined when  $T$  and  $u$  are given specific values. Suppose  $T$ , which is the time length  
 5 from the start time of the first playback operation to the stop time of the  $y$ th playback operation, is 1200sec. Also suppose the upper limit to the number of displayable thumbnails in one program navigation area is ten. Then step S81 is performed to calculate  $u=4$  that satisfies  
 10  $10=1+2+3+4$ . After this, steps S86-S91 are performed.

When  $v=1$ ,  $w$  whose upper limit is  $v$  takes the value of 1. Accordingly, the loop is performed once, as a result of which array element  $H[1]$  is determined. Since array element  $H[0]$  is 0sec and  $T/(u \cdot 1)$  is 300sec( $=1200/4$ ),  
 15 array element  $H[1]$  is set at 300sec( $=300+0$ ).

When  $v=2$ ,  $w$  takes the values of 1 and 2. Accordingly, the loop is performed twice, as a result of which array elements  $H[2]$  and  $H[3]$  are determined. Since array element  $H[1]$  is 300sec and  $T/(u \cdot 2)$  is  
 20 150sec( $=1200/(4 \cdot 2)$ ), array element  $H[2]$  is set at 450sec( $=300+150$ ). Since array element  $H[2]$  is 450sec and  $T/(u \cdot 2)$  is 150sec( $=1200/4 \cdot 2$ ), array element  $H[3]$  is set at 600sec( $=450+150$ ). When  $v=3$ ,  $w$  takes the values of 1, 2, and 3. Accordingly, the loop is performed three  
 25 times, as a result of which array elements  $H[4]$ ,  $H[5]$ ,

and  $H[6]$  are determined. Since array element  $H[3]$  is 600sec and  $T/(u \cdot 3)$  is 100sec( $=1200/(4 \cdot 3)$ ), array element  $H[4]$  is set at 700sec( $=600+100$ ). Since array element  $H[4]$  is 700sec and  $T/(u \cdot 3)$  is 100sec( $=1200/(4 \cdot 3)$ ), array  
5 element  $H[5]$  is set at 800sec ( $=700+100$ ).

The same process is repeated until all array elements are determined. FIG. 21B shows thumbnails which are placed in the program navigation area when array elements  $H[0]$ ,  $H[1]$ ,  $H[2]$ ,  $H[3]$ , ... are determined  
10 as shown in FIG. 21A.

According to this embodiment, more thumbnails are used for the latter part of the viewed part of video content. This helps the user recall the contents of the viewed part more clearly.

15 In this embodiment, more thumbnails are used near the playback stop time than near the playback start time. In contrast, more thumbnails may be used near the playback start time than near the playback stop time.

This embodiment is based on the first modification  
20 to the first embodiment where  $N$  pieces of picture data are chosen from the viewed part and thumbnails of these pieces of picture data are placed in the thumbnail area. The reason for using the first modification to the first embodiment as a basis is to make it clear that more  
25 thumbnails are used near the playback stop time than near

the playback start time. However, the third embodiment may equally be based on the first embodiment where ratio  $\alpha$  of the viewed part to the whole video content is calculated,  $\alpha N$  pieces of picture data are chosen from  
 5 the viewed part, and thumbnails of these pieces of picture data are placed in the thumbnail area.

Also, it should be noted that the above method of setting  $\Delta t$  is merely one example. Other methods can be equally used so long as more thumbnails are used near  
 10 the playback stop time than near the playback start time.

One example of such methods is given below. First,  $u$  that satisfies  $N=1+2+3+4+5+\dots+u$  is calculated for  $N$  which is the upper limit to the number of displayable thumbnails in one program navigation area. Then the  
 15 array elements are determined using time intervals  $T \cdot (u/N), \dots, T \cdot (4/N), T \cdot (3/N), T \cdot (2/N), T \cdot (1/N)$ . Which is to say, the array elements are determined such that:

$$\begin{aligned} H[1] &= H[0] + T \cdot (u/N) \\ 20 \quad H[2] &= H[1] + T \cdot ((u-1)/N) \\ H[3] &= H[2] + T \cdot ((u-2)/N) \\ H[4] &= H[3] + T \cdot ((u-3)/N) \\ H[5] &= H[4] + T \cdot ((u-4)/N) \end{aligned}$$

25 With this method too, more thumbnails are used near



the playback stop time than near the playback start time.

(Fourth Embodiment)

The first embodiment is based on the assumption  
5 that video content is played from the beginning, and  
therefore the viewed part of the video content is  
basically one continuous sequence. However, when  
playing video content recorded on the DVD 100, the user  
often views only the desired part while fast-forwarding  
10 commercials and unwanted part (the fast forward referred  
to in this embodiment includes double-speed playback  
that can adjust speeds by jog dialing or the like).

Accordingly, the playback controlling unit 13 in  
the fourth embodiment uses a different way of expressing  
15 a playback history. In the first embodiment, a start  
time of a playback operation on video content is either  
the beginning of the video content or the point when the  
playback of the video content is resumed. Even when fast  
forward is performed during the playback operation, such  
20 fast forward is not taken into consideration in the  
playback history. In the fourth embodiment, on the  
other hand, if normal playback is switched to fast  
forward during the playback operation, the point at which  
the fast forward starts is set as a stop time. Also,  
25 if fast forward is switched back to normal playback,

the point at which the normal playback restarts is set as a start time. In doing so, only the part of the video content on which normal playback is performed is recorded in the playback history, while excluding the part of the video content on which fast forward is performed.

Since only the part on which normal playback is performed is included in the playback history, no pieces of picture data are chosen from the part on which fast forward is performed and therefore no thumbnails of the fast-forwarded part are displayed on the GUI screen. As a result, even if the user has viewed the video content while skipping some parts, the user can be presented with the details of the viewed part.

FIG. 22A shows how a playback history is expressed when a point of switching from normal playback to fast forward is set as a stop time and a point of switching from fast forward back to normal playback is set as a start time. In the drawing, fast forward start ty1 and normal playback return ty2 and then fast forward start ty3 and normal playback return ty4 are conducted between playback start ty0 and playback stop ty5. In such a case, ty1 where fast forward starts is the stop time of the yth playback operation, and ty2 where normal playback resumes is the start time of the (y+1)th playback operation. Also, ty3 where fast forward starts is the

stop time of the  $(y+1)$ th playback operation, and  $ty_4$  where normal playback resumes is the start time of the  $(y+2)$ th playback operation. Lastly,  $ty_5$  where the playback of video content  $x$  stops is the stop time of the  $(y+2)$ th playback operation. FIG. 22B shows an example of playback history stored in the work area 14 when the playback shown in FIG. 22A has been conducted.

FIG. 23 is a flowchart of processing performed by the playback controlling unit 13 in the fourth embodiment. FIG. 24 is a flowchart of processing performed by the GUI updating unit 15 in the fourth embodiment. FIGS. 23 and 24 correspond to FIGS. 5 and 6 in the first embodiment, respectively.

The processing shown in FIG. 23 comes after steps S12-S15 shown in FIG. 5. The difference from FIG. 5 lies in that the number of playback operations of video content  $x$  is expressed by  $y+r$ . Variable  $r$  corresponds to the number such as "1" or "2" of the playback operation number " $y+1$ " or " $y+2$ " shown in FIG. 22A.

FIG. 23 is explained first. The playback controlling unit 13 sets variable  $r$  to 0 (S99). After this, the playback controlling unit 13 acquires a PTS (S18), and stores the PTS in the work area 14 as the start time of the  $(y+r)$ th playback operation (S19). Then a loop of steps S100-S101 and S21-S20 is performed. Here,

if normal playback is switched to fast forward, the judgement "YES" is given in step S100. Accordingly, the playback controlling unit 13 instructs the MPEG decoder 4 and the DVD drive 1 to fast-forward (S102). The  
5 playback controlling unit 13 then acquires a PTS (S103), and stores the PTS in the work area 14 as the stop time of the  $(y+r)$ th playback operation (S109).

If fast forward is switched back to normal playback, the judgement "YES" is given in step S101. Accordingly,  
10 the playback controlling unit 13 instructs the MPEG decoder 4 and the DVD drive 1 to perform normal playback (S105). The playback controlling unit 13 then increments variable  $r$  by 1 (S106). After this, the playback controlling unit 13 acquires a PTS (S107), and  
15 stores the PTS in the work area 14 as the start time of the  $(y+r)$ th playback operation (S108).

When the playback of video content  $x$  is stopped or when video content  $x$  ends, the same process as in FIG. 5 is carried out. Which is to say, the playback  
20 controlling unit 13 acquires a PTS (S23), and stores the PTS in the work area 14 as the stop time of the  $(y+r)$ th playback operation (S24). The processing then returns to the main routine of FIG. 4A.

FIG. 24 is explained next. After steps S31-S34 and  
25 S39-S40 shown in FIG. 6, the GUI updating unit 15 resets

variable  $r$  to 0 (S109). The GUI updating unit 15 then stores the start time of the  $(y+r)$ th playback operation in array element  $H[k]$  (S35). After this, if the sum of array element  $H[k]$  and  $\Delta t$  does not exceed the stop time of the  $(y+r)$ th playback operation (S36:NO), the sum of array element  $H[k]$  and  $\Delta t$  is stored in array element  $H[k+1]$  (S37), and variable  $k$  is incremented by 1 (S38).

If the sum of array element  $H[k]$  and  $\Delta t$  exceeds the stop time of the  $(y+r)$ th playback operation (S36:YES), the GUI updating unit 15 increments variable  $r$  by 1 (S110). The GUI updating unit 15 then judges whether variable  $r$  exceeds the last number (S111). If variable  $r$  does not exceed the last number (S111:NO), the GUI updating unit 15 returns to step S35.

As a result, each pair of start time and stop time specified by variable  $r$  are processed. Following this, the GUI updating unit 15 advances to steps S41-S51 shown in FIG. 6.

According to this embodiment, when the user views video content while skipping some parts by fast-forwarding, thumbnails of only the viewed parts and not of the skipped parts are displayed on the GUI screen.

In this embodiment, a point where normal playback is switched to fast forward is set as a playback stop time and a point where fast forward is switched back to

normal playback is set as a playback start time. As an alternative, a point where normal playback is switched to special playback and a point where special playback is switched back to normal playback may respectively be  
5 set as a playback stop time and a playback start time. Special playback includes not only fast forward but also rewind, pause, and chapter jump. For instance, a point where normal playback is switched to rewind and a point where rewind is switched back to normal playback may be  
10 set as a playback stop time and a playback start time respectively. Also, a point where normal playback is switched to special playback such as pause or chapter jump and a point where special playback is switched back to normal playback may be set as a playback stop time  
15 and a playback start time respectively.

(Fifth Embodiment)

The fifth embodiment relates to when the present invention is applied to a streaming delivery system of  
20 video content. In the first embodiment, the playback apparatus is owned by the user, and plays video content recorded on a recording medium. On the other hand, video content delivered in a streaming delivery system is not recorded on a recording medium of a playback apparatus  
25 owned by the user.

FIG. 25 shows a construction of a streaming delivery system to which the fifth embodiment relates. In the drawing, the streaming delivery system is roughly made up of a client apparatus 21 and a server apparatus 5 22 which are connected via a network 20. The above function of the playback apparatus is divided into the client apparatus 21 and the server apparatus 22.

The client apparatus 21 is equipped with the MPEG decoder 4 of the playback apparatus. Since video 10 content itself is recorded in a recording medium of the server apparatus 22, the client apparatus 21 sends a playback request to the server apparatus 22 via the network 20 and plays back video content received from the server apparatus 22. When performing the playback 15 operation, the client apparatus 21 sends the start time and stop time of the playback operation to the server apparatus 22 via the network 20.

The server apparatus 22 has a function similar to the playback apparatus that is equipped with the DVD 20 drive 1, the microcomputer system 11, and the work area 14. The difference with the playback apparatus lies in that a request to play video content is sent from the user of the client apparatus 21 via the network 20 and the requested video content is sent to the client 25 apparatus 21 in compressed form without being played by

the server apparatus 22 itself. Since the server apparatus 22 does not perform playback operations, the server apparatus 22 cannot combine GUI data by OSD with a video signal as in the first embodiment. Instead, the  
5 server apparatus 22 generates a page having the same contents as the GUI screen of the first embodiment, and sends it to the client apparatus 21.

As shown in FIG. 25, the server apparatus 22 includes a content storage 23, a database 24, an  
10 authenticating unit 25, a page retaining unit 26, a page generating unit 27, a downloading unit 28, and a page updating unit 29.

The content storage 23 is a recording medium corresponding to the DVD 100 of the first embodiment, and stores a plurality of sets of video content.  
15

The database 24 stores user management information for each individual user. In more detail, personal information of each individual user such as a name, birthday, telephone number, and mail address is stored  
20 together with a user ID of the user, a video content ID of video content which the user has requested viewing, and playback start time and stop time of the video content.

The authenticating unit 25 performs two types of  
25 authentication that are user authentication and video



content authentication. User authentication is a process of requesting a user who has requested viewing to send a user ID, and comparing the received user ID with a user ID included in the user management information. Video content authentication is a process of requesting a user who has requested viewing to send a video content ID and comparing the received video content ID with a video content ID included in the user management information. Video content authentication is conducted because of the need of the content deliverer side to confirm whether the user certainly paid for the video content he or she has requested. The video content is sent to the user only when these two authentication processes are successful.

15           The page retaining unit 26 corresponds to the work area 14 in the first embodiment, and stores page data that has the same contents as the GUI screen by OSD.

          The page generating unit 27 corresponds to the GUI generating unit 12 in the first embodiment. The page generating unit 27 inquires the user whether program navigation is needed. If the user requests program navigation, the page generating unit 27 generates a program navigation page which has the same contents as the GUI screen of the first embodiment, and stores it in the page retaining unit 26. The navigation page is

then sent to the user. The user can designate video content to be played back, on this navigation page.

The downloading unit 28 corresponds to the GUI generating unit 12 in the first embodiment. The  
5 downloading unit 28 sends the video content which the user has designated on the navigation page, to the client apparatus 21. The downloading unit 28 then waits for receiving playback start time and stop time from the client apparatus 21. Upon receiving the playback start  
10 time and stop time, the downloading unit 28 stores them in the database 24.

The page updating unit 29 corresponds to the GUI updating unit 15 and the thumbnail generating unit 16 in the first embodiment. The page updating unit 29  
15 chooses pieces of picture data from a part of the video content between the playback start time and stop time notified by the user, and places thumbnails of these pieces of picture data on the navigation page stored in the page retaining unit 26 to update the navigation page.  
20 The updated page is then sent to the user.

FIGS. 26 and 27 are sequence charts of processing performed in the streaming delivery system of the fifth embodiment. Among the construction elements of the server apparatus 22 shown in FIG. 25, the content storage  
25 23 and the database 24 are separately shown from the other

construction elements (the authenticating unit 25, the page generating unit 27, the downloading unit 28, and the page updating unit 29). These other construction elements are put together as the server apparatus 22.

5       The client apparatus 21 accesses the server apparatus 22 (y1). The authenticating unit 25 requests the client apparatus 21 to send a user ID (y2). The client apparatus 21 accordingly sends the user ID (y3). The authenticating unit 25 reads a user ID stored in the  
10       database 24 (y4), and compares the received user ID with the read user ID (y5).

      If they match, the authenticating unit 25 requests the client apparatus 21 to send a video content ID (y6). The client apparatus 21 accordingly sends the video  
15       content ID (y7). The authenticating unit 25 reads a video content ID stored in the database 24 (y8), and compares the received video content ID with the read video content ID (y9), to authenticate the user.

      Once the validity of the user has been successfully  
20       verified through these two authentication processes, the page generating unit 27 inquires the client apparatus 21 as to whether a navigation page is necessary (y10). If the client apparatus 21 requests a navigation page (y11), the page generating unit 27 generates a navigation  
25       page with thumbnails (y12), and sends the page to the

client apparatus 21 (y13). When video content x is selected on this page, the selection is notified to the server apparatus 22 (y14).

The downloading unit 28 reads video content x from  
5 the content storage 23, and sends it to the client apparatus 21. Suppose video content x is made up of a plurality of portions 1/n, 2/n, 3/n, 4/n, and 5/n. This being so, the downloading unit 28 sends video content 1/n to the client apparatus 21 (y21). In response, the  
10 client apparatus 21 notifies the server apparatus 22 of a playback start time (y22). The downloading unit 28 stores the playback start time in the database 24. The downloading unit 28 then sequentially sends video content 2/n, 3/n, 4/n, and 5/n (y23, y24, y25, and y26).  
15 Suppose the client apparatus 21 stops the playback operation when video content 5/n is sent to the client apparatus 21. The client apparatus 21 notifies the server apparatus 22 of a playback stop time. The downloading unit 28 stores the playback stop time in the  
20 database 24 (y27). The page updating unit 29 accesses the content storage 23 (y28) and chooses pieces of picture data from part of video content x between the playback start time and stop time (y29). The page updating unit 29 updates the navigation page by placing  
25 thumbnails of these pieces of picture data. The updated

page is then sent to the client apparatus 21 (y30). From this page, the user can recall the contents of the viewed part.

According to this embodiment, the server apparatus  
5 generates a navigation page on which a plurality of thumbnails are placed. Accordingly, even if video content is not recorded on a recording medium which can be handled by a playback apparatus but is managed by a delivery server, the user can easily recall up to which  
10 episode he or she has previously viewed or what the psychological states and actions of the characters in that episode were, as in the first embodiment. Hence the user can concentrate on further viewing.

15 (Sixth Embodiment)

The first to fourth embodiments describe the case where video content is composed only of a VOB. The sixth embodiment relates to a technique of displaying thumbnails as in the first to fourth embodiments, in  
20 consideration of management information which is also included in the video content. The management information referred to here conforms to the DVD-Video Recording standard. In this embodiment, management information for a plurality of sets of video content are  
25 stored in a single file called a management file and

recorded on the DVD 100.

FIG. 28 shows an inner structure of the management file VR\_MANGR.IFO (Video Recording Manager Information). As illustrated, VR\_MANGR.IFO includes an RTR\_VMGI table (RTR\_VMGIT), an M\_AVFI table (M\_AVFIT), and an ORG\_PGCI table (ORG\_PGCIT).

The M\_AVFI (Motion AV File Information) table is a management table for VOBs. As indicated by guidelines h3 drawn using broken lines, the M\_AVFI table includes VOB\_STI\_Ns, M\_AVFIT\_EA, VOB STI#1 to #K, and M\_AVFI. VOB\_STI\_Ns shows the number of VOB\_STI included in this M\_AVFIT. M\_AVFIT\_EA (Effective Address) shows the effective length of this M\_AVFIT. VOB STI#1 to #K (Stream Information) are each attribute information for the VOBs. VOB STI shows a video attribute of picture data in the VOBs (e.g. coding mode, aspect ratio, NTSC/PAL, line 21 information) and an audio attribute of audio data in the VOBs (e.g. coding mode, channel number, frequency).

M\_AVFI (Motion AV File Information) is made up of VOB\_I#1 to #L, as indicated by guidelines h4. VOB\_I (Video Object Information) is playback control information unique to an individual VOB. As indicated by guidelines h5, VOB\_I is made up of M\_VOB\_GI (General Information) and TMAP\_I (Time Map Information). TMAP\_I is time map

information for VOBUs that constitute the VOB. M\_VOB\_GI includes VOB\_TY, VOB\_REC\_TM, and M\_VOB\_STIN, as indicated by guidelines h6. VOB\_TY shows the type of the VOB. VOB\_REC\_TM (VOB Recording Time) shows the date and time when the first picture data of the VOB was recorded. M\_VOB\_STIN (Stream Information Number) designates one of VOB STI#1 to #K which corresponds to the VOB, as shown by arrow Pr1.

The following explains about TMAPI. TMAPI is a table that associates the addresses of the VOBUs with playback times. FIG. 29 shows a structure of TMAPI. As indicated by guidelines hy3, TMAPI includes TMAP\_GI (General Information), TM\_ENT#1 to #S (Time Entry), and VOBU\_ENT#1 to #T (VOBU Entry).

VOBU\_ENT is information corresponding to each VOB. As indicated by guidelines hy4, VOBU\_ENT includes 1STREF\_SZ, VOBU\_PB\_TM, and VOBU\_SZ. 1STREF\_SZ (1st Reference Size) shows the size of an I picture which is located at the beginning of the VOB. VOBU\_PB\_TM (VOBU Playback Time) shows the playback duration of the VOB in units of 0.4-1.0sec. VOBU\_SZ (VOBU Size) shows the size of the VOB. Since the variable-length coding compression technique is used, the size and playback duration of each VOB varies. Even so, with reference to VOBU\_ENT, it is possible to locate picture data in

a VOB that corresponds to a given playback time.

TM\_ENT is information showing the location of a time entry which appears with intervals of 10sec. As indicated by guidelines hy5, TM\_ENT includes VOBU\_ENTN, 5 TM\_DIFF, and VOBU\_ADR. VOBU\_ENTN shows a VOB that includes the time entry. TM\_DIFF shows an offset from the beginning of the VOB shown by VOBU\_ENTN to the time entry. VOBU\_ADR shows an offset from the beginning of the VOB to the beginning of the VOB. With reference 10 to this TM\_ENT, it is possible to locate picture data with long time intervals such as 10sec, at high speed.

TMAP\_GI (Time Map General Information) is information for managing overall TMAPI. As indicated by guidelines hy6, TMAP\_GI includes TM\_ENT\_Ns, 15 VOBU\_ENT\_Ns, TM\_OFS, and ADR\_OFS. TM\_ENT\_Ns shows the number of time entries which are provided in the VOB. VOBU\_ENT\_Ns shows the number of VOBU\_ENT in TMAPI. TM\_OFS shows an offset from the beginning of the VOB to a time entry. ADR\_OFS shows an offset from the beginning 20 of VR\_MOVIE.VRO to the beginning of the VOB.

FIG. 30 is a representation of the relationship between TMAPI and VOBUs. The correspondence between the playback duration and size of each VOB is shown by a combination of VOBU\_PB\_TM ("PB\_TM" in FIG. 30) and 25 VOBU\_SZ. Also, TM\_DIFF in TM\_ENT shows how many seconds



it takes from the beginning of a VOB to a time entry. With the provision of such TMAPI, it is possible to specify a VOB that corresponds to a given time code.

The thumbnail generating unit 16 uses this TMAPI to specify a piece of picture data corresponding to elapsed time stored in array element H[k].

A piece of picture data corresponding to array element H[k] can be found from the beginning of a VOB, in the following way. First, x, y, and z that satisfy Equation 4 are calculated in FIG. 30.

$$H[k] = 10\text{sec} \times x - (\text{TM\_DIFF of TM\_ENT\#}x+1) + \text{TM\_OFS} + \sum \text{VOBU\_PB\_TM} + z$$

(where  $\sum \text{VOBU\_PB\_TM}$  is the sum total of the first VOB to the yth VOB)  
 ..... (Equation 4)

Then x and y are assigned to Equation 5, to find an address of VOB#i to which the piece of picture data corresponding to array element H[k] belongs.

$$(\text{address of VOB\#}i) = \text{ADR\_OFS} + (\text{VOBU\_ADR of TM\_ENT\#}x+1) + \sum \text{VOBU\_SZ}$$

(where  $\sum \text{VOBU\_SZ}$  is the sum total of the first VOB to the yth VOB)

..... (Equation 5)

The thumbnail generating unit 16 has the DVD drive  
1 read VOB#i from the DVD 100 at the found address, and  
5 has the MPEG decoder 4 decode VOB#i. While VOB#i is  
being decoded, a piece of picture data that appears when  
time z has elapsed from the playback start time of VOB#i  
is the piece of picture data corresponding to array  
element H[k]. Once this piece of picture data has been  
10 stored in the frame memories 8a-8c, the thumbnail  
generating unit 16 reduces the piece of picture data to  
obtain a thumbnail. The thumbnail generating unit 16  
then places the thumbnail on the GUI screen. This is  
the processing of the thumbnail generating unit 16 in  
15 the sixth embodiment.

The remaining tables in VR\_MANGR.IFO are explained  
by referring to FIG. 31. FIG. 31 shows an inner  
structure of the ORG\_PGCI table, in addition to the inner  
structure of the M\_AVFI table.

20 The ORG\_PGCI (Original Program Chain Information)  
table is a table for exercising management so that the  
plurality of VOBs recorded on the DVD 100 can be handled  
as if they were a single video tape. In more detail,  
the ORG\_PGCI table serially arranges the plurality of  
25 VOBs recorded on the DVD 100 to form a playback path

called an original program chain. This allows the user to treat the DVD 100 on which the plurality of VOBs are recorded just like a single video tape. In this embodiment, the plurality of VOBs are arranged so that those with earlier recording dates and times come first, with reference to VOB\_REC\_TM in VOB\_I. The relationship between ORG\_PGCI and VOBs is as follows. VOBs have a logical hierarchy of "PG-cell-VOB". This being so, ORG\_PGCI is the outcome of connecting PGs (programs) of the highest level into a single string. A PG in the logical hierarchy "PG-cell-VOB" is equivalent to video content described in the first to fourth embodiments.

The ORG\_PGCI table is designed to realize the logical hierarchy "PG-cell-VOB". In FIG. 31, the ORG\_PGCI table includes ORG\_PGCI\_EA, PG\_Ns, CI\_SRP\_Ns, ORG\_PGI#1 to #M, ORG\_CI\_SRP\_Ns, ORG\_CI\_SRP#1 to #N, and ORG\_CELLI#1 to #N, as indicated by guidelines h6. ORG\_PGCI\_EA (Effective Address) shows the effective length of the ORG\_PGCI table. PG\_Ns shows how many PGs are connected into the ORG\_PGC. CI\_SRP\_Ns shows the number of search pointers for CELLI (CI). ORG\_PGI#1 to #M are each information for a PG included in the ORG\_PGC. ORG\_CI\_SRP#1 to #N are each a search pointer for CELLI.

ORG\_CELLI is information for specifying a logical playback segment using a combination of time codes. As

indicated by guidelines h8, ORG\_CELLI includes  
VOBI\_SRPN, CELL\_Start\_PTM, and CELL\_End\_PTM.

VOBI\_SRPN is a pointer designating VOB in M\_AVFIT that  
corresponds to this CELLI, as shown by arrow gj1.

- 5 CELL\_Start\_PTM and CELL\_End\_PTM are a combination of  
time codes for designating a playback segment (cell) in  
the VOB.

FIG. 32 shows the relationship between cells and  
VOBs in ORG\_PGCI. In the drawing, VOB\_SRPN shows VOB  
10 that corresponds to each cell. CELL\_Start\_PTM  
("C\_S\_PTM" in FIG. 32) and CELL\_End\_PTM ("C\_E\_PTM") in  
each cell are converted to two addresses of VOBUs through  
TMAPI, as a result of which a segment in a VOB is specified  
as the cell.

- 15 In FIG. 31, ORG\_PGI (Original Program Information)  
includes IT\_TXT\_SRPN and C\_Ns, as indicated by  
guidelines h7. IT\_TXT\_SRPN specifies text data in  
TXTDT\_MG that corresponds to this PG. C\_Ns shows the  
number of cells included in the PG.

- 20 FIG. 33 shows how the cells shown in FIG. 32 are  
grouped in PGs. As illustrated, it is clear from C\_Ns  
in PGI which of cell#1 to #2 in ORG\_PGCI is included in  
PG#1 and which is included in PG#2. Furthermore,  
IT\_TXT\_SRPN in each PG shows text data corresponding to  
25 the PG.

Thus, video content has the logical hierarchy "PG-cell-VOB". The reason that video content has such a hierarchy is to facilitate editing on the video content.

5        Suppose video content 1 and video content 2 are each a PG that has the logical hierarchy "PG-cell-VOB". The following explains how the hierarchy of each of video content 1 and video content 2 changes when partial deletes are performed on VOBs of these video content.

10        FIG. 34 shows how parts of VOBs are designated when partial deletes are performed. As shown in the fourth level in FIG. 34A, video content 1 and video content 2 are recorded on the DVD 100 as VOB#1 and VOB#2. These VOBs are managed as cells in the third level. These VOBs  
15        are also managed as PGs in the second level. These two PGs are combined to form an ORG\_PGC in the first level.

      Suppose, after the VOBs, cells, and PGs of video content 1 and video content 2 are recorded on the DVD 100, parts pt1 and pt2 of VOB#1 and parts pt3 and pt4  
20        of VOB#2 are designated as partial delete areas, as shown in FIG. 34B. When these parts are deleted, old VOB#1 is divided into three VOBs that are new VOB#1, VOB#2, and VOB#3 before and after parts pt1 and pt2, as shown in FIG. 35. Likewise, old VOB#2 is divided into three  
25        VOBs that are new VOB#4, VOB#5, and VOB#6. As a result,

old cell#1 is divided into three cells that are new cell#1, cell#2, and cell#3, and old cell#2 is divided into three cells that are new cell#4, cell#5, and cell#6. However, three cells that have been generated as a result of partial deletes remain to be included in the same PG as the original cell. In other words, before the partial deletes, video content 1 is managed as PG#1 that includes one cell and one VOB. After the partial deletes, video content 1 is managed as PG#1 that includes three cells and three VOBs. Likewise, before the partial deletes, video content 2 is managed as PG#2 that includes one cell and one VOB. After the partial deletes, video content 2 is managed as PG#2 that includes three cells and three VOBs.

Thus, the identity of video content is unchanged before and after partial deletion. Accordingly, if video content is a PG, management can be conducted easily when editing operations such as partial deletion are performed.

If partial deletion is performed, the playback apparatus updates the GUI screen in the same way as above. In detail, the playback apparatus detects a part of a PG after the partial deletion that corresponds to a start time and stop time of a playback operation, and chooses pieces of picture data with intervals of  $\Delta t$  from the part

of the PG. The playback apparatus generates thumbnails of these pieces of picture data, and places the thumbnails on a program navigation area of the PG to update the GUI screen. This prevents thumbnails of part  
5 of video content which was deleted by partial deletion, to be displayed on the GUI screen.

According to this embodiment, the processing of the first to fourth embodiments is performed on video content that is recorded according to the DVD-Video Recording  
10 standard. This enables playback control for DVD-RAM or DVD-RW on which video content is recorded according to the DVD-Video Recording standard, to be exercised favorably.

This embodiment describes the case where video  
15 content is a PG, but other playback units may instead be used as long as they have a hierarchy similar to a PG. For example, Playlist defined by the DVD-Video Recording standard may be used (Playlist has a hierarchy of "VOB-VOBI-cell"). VideoTitle defined by the DVD-  
20 Video standard may equally be used (VideoTitle has a hierarchy of "VOB-cell-PGC").

(Modifications to the First to Sixth Embodiments)

The present invention has been described by way of  
25 the above embodiments, though these embodiments are mere

examples of systems that are presently expected to operate favorably. It should be obvious that various modifications can be made without departing from the technical scope of this invention. Examples of such  
5 modifications are given below.

(A) The first to sixth embodiments can be modified so as to receive a selection of a thumbnail in a thumbnail area of a program navigation area from the user and start playing video content from a position corresponding to  
10 the thumbnail. In such a case, each thumbnail has the three states of normal, focus, and active just like a program navigation area. This being so, the user operates the arrow keys on the remote control to change some thumbnail from the normal state to the focus state.  
15 The user then presses the ENTER key on the remote control to set the thumbnail in the active state. When this happens, the playback controlling unit 13 locates a piece of picture data of video content corresponding to the selected thumbnail, and starts playback from that piece  
20 of picture data.

(B) The first to sixth embodiments describe the case where a playback history of a playback operation is expressed by a combination of start time and stop time. As an alternative, the playback history may be expressed  
25 using logical addresses (LSN: logical sector number) on



the DVD or relative addresses in files. Also, though the start time and the stop time are indicated by PTSs in the above embodiments, they may instead be indicated by times shown by a timer. Also, the start time and the stop time may be indicated using time stamps other than PTS.

(C) The first to fourth embodiments and the sixth embodiment may be modified so that the playback apparatus has a home server function. Such a playback apparatus is equipped with an MPEG encoder and a hard disk with a capacity of several tens of gigabytes, and can write a large amount of video content on the hard disk.

The first to fourth embodiments and the sixth embodiment describe the case where the playback apparatus is connected to the television 101 and put to use. However, the playback apparatus may be integrated with a liquid crystal display. Also, though the playback apparatus shown in the first embodiment includes devices from the DVD drive 1 to the MPEG decoder 4, these devices may be separately provided and connected to the playback apparatus via an IEEE 1394 connector. Furthermore, the first to fourth embodiments and the sixth embodiment may be modified so that the playback apparatus is made up of only the microcomputer system 11 that performs main processing.

Since the playback apparatus of each of the above embodiments is an invention described in this specification, an act of manufacturing a playback apparatus based on the inner construction of the playback apparatus described in the embodiment is an act of  
5 working of the present invention. Also, any act of assigning for sale or for free, leasing, or importing the playback apparatus is an act of working of the present invention. Likewise, an act of offering for assignment  
10 or lease of the playback apparatus using storefront displays, catalogs, or brochures is an act of working of the present invention.

(D) Information processing using the programs shown in FIGS. 4-6, 15-18, 20, and 23-24 is actually  
15 realized by hardware resources such as a CPU, an MPEG decoder, and a DVD drive. Which is to say, the playback apparatus of each of the above embodiments is realized whereby specific means that is provided with software and hardware performs information processing in  
20 accordance with the intended use of placing a plurality of thumbnails on a GUI screen.

Given that the information processing by the programs is actually realized by the hardware resources, the programs shown in the above flowcharts can be  
25 regarded as a creation of technical ideas by which a law

of nature is utilized. This means the programs themselves are an invention. In other words, the procedures shown in the above flowcharts represent an act of working of the programs of the present invention.

5       The first to fourth embodiments and the sixth embodiment describe the case where the programs are incorporated in the playback apparatus. However, the programs can be used independently of the playback apparatus. Acts of working of the programs include (1)  
10   an act of manufacturing, (2) an act of assigning for sale or for free, (3) an act of leasing, (4) an act of importing, (4) an act of providing to the public via a bi-directional electronic communication network, and (6) an act of offering for assignment or lease using storefront  
15   displays, catalogs, or brochures.

      Examples of the act (5) include an act in which a provider sends a program to a user (program download service) and an act in which the provider provides only the function of the program to the user via the electronic  
20   communication network without sending the program itself (function provision ASP service).

      (E) The time elements of the steps which are executed in a time series in each of the above flowcharts can be regarded as the necessary elements of the present  
25   invention. This being so, a playback method shown by

each of these flowcharts is an invention. If the processing shown in each flowchart is carried out by performing the steps in a time series so as to achieve the intended use of placing a plurality of thumbnails  
5 on a GUI screen, this is an act of working of the playback method of the present invention.

(F) The first to fourth embodiments and the sixth embodiment describe an example where a DVD is used as a recording medium on which video content is recorded.  
10 However, the present invention is not limited to the use of this recording medium. The same effects can still be achieved even when other recording media which have a capacity of recording video content like a DVD are used. Examples of such recording media include: an optical disc  
15 such as a CD-R, a CD-RW, or a Blue-ray disc; a magneto-optical disc such as a PD or an MO; a semiconductor memory card such as an SD memory card, a CompactFlash card, a SmartMedia card, a Memory Stick card, a MultiMediaCard, or a PCMCIA card; a magnetic disk such  
20 as a flexible disk, SuperDisk, Zip, or Clik!; and a removable hard disk drive such as ORB, Jaz, SparQ, SyJet, EZFley, or Microdrive.

(G) In the first to fourth embodiments and the sixth embodiment, video content is described as being a VOB  
25 that is obtained by encoding an analog video signal

broadcast by analog broadcasting. However, video content may instead be stream data formed by a transport stream broadcast by digital broadcasting.

Also, video content may be obtained by encoding an  
5 analog/digital video signal recorded on a video tape. Furthermore, video content may be obtained by encoding an analog/digital video signal acquired directly from a video camera. Alternatively, video content may be a  
10 digital work, such as a movie, that is distributed having been recorded on a recording medium or distributed via a delivery server.

Also, video content in the above embodiments may be a broadcast program unit specified by a broadcast station.

15 (H) The first embodiment describes the case where pieces of picture data are chosen with intervals of  $\Delta t$ . However, if a time length of a viewed part between a playback start time and a playback stop time is shorter than  $\Delta t$ , there may be no piece of picture data to be chosen  
20 from the viewed part. Suppose  $\Delta t=300\text{sec}$  as in the case of FIGS. 8 and 9. If the viewed part is shorter than 300sec, there may be no piece of picture data to be chosen from the viewed part. In such a case, the GUI screen cannot be updated. To solve this problem, the first  
25 embodiment may be modified so as to definitely choose

at least one piece of picture data from any viewed part.  
For example, a piece of picture data located at around  
a midpoint between the playback start time and the  
playback stop time may be chosen from the viewed part.

5       Also, the first embodiment describes the case where  
pieces of picture data are chosen with intervals of  $\Delta t$   
from a viewed part between a playback start time and a  
playback stop time. However, if a locating point such  
as a chapter or a mark exists in the viewed part, a  
10   thumbnail of a piece of picture data corresponding to  
the chapter or mark may be displayed.

(I) The first to sixth embodiments describe the  
case where a video stream and an audio stream are  
multiplexed in a VOB. However, a sub-picture stream in  
15   which subtitle characters are run-length compressed or  
other control information may be multiplexed, too. Also,  
while the MPEG decoder 4 uses a codec of the MPEG2 image  
decompression/decoding standard, codecs of other  
standards (e.g. MPEG1 or MPEG4) are also applicable.

20       (J) In the first to sixth embodiments, the  
arrangement of thumbnails may be modified so as to be  
more pleasing to the eye. For instance, a plurality of  
thumbnails may be arranged horizontally or vertically  
with a pattern that resembles a film of a movie.  
25   Alternatively, they may be arranged like panels of a

comic book. Also, ornamental frames may be employed.

(K) The first to sixth embodiments describe an example where thumbnails are placed on a GUI screen, but a simple listing screen for listing a plurality of sets  
5 of video content may instead be used, as a wallpaper image or the like. Also, though the playback apparatus generates the GUI screen made up of program navigation areas in the first to fourth embodiments and the sixth embodiment, page data written in a page description  
10 language such as HTML or BML is applicable too. Also, the first to fourth embodiments and the sixth embodiment describe the case where a user selection of video content is received via a remote control. However, the user selection may be received via a front panel of the  
15 playback apparatus, or via an input device such as a keyboard, a touch panel, a mouse and a pad, or a track ball. In the latter case, the user selection is made by clicking or dragging.

(L) In the first embodiment, the size of each  
20 program navigation area is fixed. As a result, some space is left in the thumbnail areas of some program navigation areas in the examples of FIGS. 8, 10, and 11. To eliminate such a space, each program navigation area may be varied in size, such that a program navigation  
25 area is small enough to contain only a thumbnail of the

first picture data when video content has not been played,  
and is increased in size as the viewed part becomes  
longer.

In the case of FIG. 8, only video content 1 has been  
5 played whereas video content 2 and video content 3 have  
not been played at all. This being so, only one  
thumbnail of the first image need be displayed for each  
of video content 2 and video content 3. Accordingly,  
the thumbnail area in the program navigation area for  
10 each of these video content is made small to contain only  
one thumbnail. This produces some redundant area which  
should originally have been used for other nine  
thumbnails of each of video content 2 and 3. Such an  
area can now be used for video content 1 which has already  
15 been played.

Originally, the thumbnail area in the program  
navigation area of video content 1 has a capacity of ten  
thumbnails. However, through the use of the redundant  
area, the thumbnail area of video content 1 can be  
20 expanded to contain  $28(=10+9+9)$  thumbnails at the  
maximum. Since the upper limit to the number of  
displayable thumbnails is increased for video content  
1,  $\Delta t$  which is obtained by dividing the playback time  
length of video content 1 by the upper limit is  
25  $107\text{sec}(=3000\text{sec}/28)$ . Hence pieces of picture data are



chosen with intervals of 1 minute and 47 seconds  
(=107sec) and thumbnails of these pieces of picture data  
are placed in the program navigation area of video  
content 1. In this way, the contents of the viewed part  
5 can be presented using more thumbnails, with it being  
possible to help the user recall the viewed part more  
clearly.

On the other hand, consider the case of dividing  
the playback time length of the viewed part by the upper  
10 limit and using the result as  $\Delta t$ . In the example of FIG.  
8,  $\Delta t = 44\text{sec} (= 1240\text{sec} / 28)$ . Accordingly, pieces of  
picture data are chosen with intervals of 44sec and  
thumbnails of these pieces of picture data are placed  
in the program navigation area of video content 1. Thus,  
15 the contents of the viewed part can be presented using  
still more thumbnails.

(M) If each of video content 1, 2, and 3 has been  
played, the program navigation area of each of these  
video content can be varied in size according to the ratio  
20 of the viewed parts of video content 1, 2, and 3, to  
eliminate redundant space.

Suppose the viewed part of video content 1 is  
1800sec, the viewed part of video content 2 is 2400sec,  
and the viewed part of video content 3 is 600sec. Then  
25 the ratio of their viewed parts is 3:4:1. The number

of thumbnails to be placed in a program navigation area of each of these video content is determined according to this ratio. That is, the upper limit to the number of displayable thumbnails for video content 1 is  $11 \div 11.25$  (=  $(10+10+10) \times 3 / (3+4+1)$ ), the upper limit for video content 2 is  $15$  (=  $(10+10+10) \times 4 / (3+4+1)$ ), and the upper limit for video content 3 is  $3 \div 3.75$  (=  $(10+10+10) \times 1 / (3+4+1)$ ). Having set the upper limits as such,  $\Delta t$  is calculated for each of these video content by dividing the playback time length of the video content by the upper limit, and pieces of picture data are chosen with intervals of  $\Delta t$  and thumbnails of these pieces of picture data are placed in the corresponding program navigation area. By doing so, the contents of the viewed part can be presented using more thumbnails.

## INDUSTRIAL APPLICABILITY

The playback apparatus of the present invention can be put to use in a home theater system or the like. This playback apparatus is manufactured in the consumer goods industry for consumer use and so provides industrial applicability. In particular, the playback apparatus helps the user recall the contents of video content recorded on a recording medium and thereby offers added values to the user. Thus, the present invention

benefits the consumer goods industry.

## CLAIMS

1. A playback apparatus for playing back video content that includes a plurality of pieces of picture data, comprising:

a displaying unit operable to display a menu which lists a plurality of sets of video content;

a playback unit operable to play back one of the plurality of sets of video content which is selected from the menu by a user, and keep a history of a playback start position and a playback stop position; and

an updating unit operable to update the menu and have the displaying unit display the updated menu, after the playback by the playback unit,

wherein the update is performed by choosing at least one piece of picture data from between the playback start position and the playback stop position in the set of video content, and placing a thumbnail of each chosen piece of picture data in the menu.

2. The playback apparatus of Claim 1, wherein if another thumbnail already exists in the menu, the updating unit places the thumbnail adjacent to the other thumbnail.

3. The playback apparatus of Claim 2,

wherein the playback by the playback unit is a  $p$ th playback operation performed on the set of video content,  $p$  being an integer no smaller than 2, and

5       the other thumbnail is a thumbnail of a piece of picture data which is located between a playback start position and a playback stop position of a  $(p-1)$ th playback operation performed on the set of video content.

10       4. The playback apparatus of Claim 1,

wherein a number of thumbnails which the updating unit places in the menu depends on a ratio of a playback time length from the playback start position to the playback stop position to a total playback time length  
15 of the set of video content.

5. The playback apparatus of Claim 4,

wherein the menu has a plurality of navigation areas which are in a one-to-one correspondence with the  
20 plurality of sets of video content,

each navigation area is given an upper limit to a number of placeable thumbnails, and

the number of thumbnails which the updating unit places in a navigation area corresponding to the set of  
25 video content is a number obtained by multiplying an upper

limit given to the navigation area by the ratio.

6. The playback apparatus of Claim 5,

wherein each chosen piece of picture data is one of  
5 a plurality of pieces of picture data that are present  
at intervals of  $\Delta t$  starting from a beginning of the set  
of video content and is located between the playback start  
position and the playback stop position, and

$\Delta t$  is a value obtained by dividing the total playback  
10 time length of the set of video content by the upper limit.

7. The playback apparatus of Claim 6,

wherein each navigation area has the same upper limit  
to the number of placeable thumbnails.

15

8. The playback apparatus of Claim 1,

wherein each chosen piece of picture data is present  
at intervals of  $\Delta t$  starting from the playback start  
position, and

20  $\Delta t$  is a value obtained by dividing a playback time  
length from the playback start position to the playback  
stop position by a predetermined value.

9. The playback apparatus of Claim 8,

25 wherein the menu has a plurality of navigation areas

which are in a one-to-one correspondence with the plurality of sets of video content,

each navigation area is given the same upper limit to a number of placeable thumbnails, and

5 the predetermined value is the same upper limit.

10. The playback apparatus of Claim 1,

wherein if another thumbnail already exists in the menu, the updating unit places the thumbnail after  
10 deleting the other thumbnail.

11. The playback apparatus of Claim 10,

wherein the playback by the playback unit is a  $p$ th playback operation performed on the set of video content,  
15  $p$  being an integer no smaller than 2, and

the other thumbnail is a thumbnail of a piece of picture data which is located between a playback start position and a playback stop position of a  $(p-1)$ th playback operation performed on the set of video content.

20

12. The playback apparatus of Claim 1,

wherein the at least one piece of picture data chosen by the updating unit is a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from  
25 the playback start position, and

$\Delta t$  is shorter near the playback stop position than near the playback start position.

13. The playback apparatus of Claim 1,  
5 wherein the at least one piece of picture data chosen by the updating unit is a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from the playback start position, and

$\Delta t$  is shorter near the playback start position than  
10 near the playback stop position.

14. The playback apparatus of Claim 1,  
wherein the updating unit chooses a plurality of pieces of picture data from between the playback start  
15 position and the playback stop position, and places a plurality of thumbnails of the respective plurality of pieces of picture data one after another in the menu so that the plurality of thumbnails are displayed like a slide show.

20

15. The playback apparatus of Claim 14,  
wherein each chosen piece of picture data is one of a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from a beginning of the set  
25 of video content and is located between the playback start



position and the playback stop position.

16. The playback apparatus of Claim 1,

wherein the playback start position is a beginning  
5 of the set of video content or a position where the user  
requests to resume playing back the set of video content,  
and

the playback stop position is a position where the  
user requests to stop playing back the set of video content  
10 or an end of the set of video content.

17. The playback apparatus of Claim 16,

wherein the playback stop position is a position  
where the user requests to switch from a normal playback  
15 mode to a special playback mode, and

the playback start position is a position where the  
user requests to switch from the special playback mode  
back to the normal playback mode.

20 18. The playback apparatus of Claim 1, further  
comprising:

a recording unit operable to record the plurality  
of sets of video content on a recording medium,

wherein the playback unit writes the history of the  
25 playback start position and the playback stop position

into the recording medium, after playing back the set of video content recorded on the recording medium, and

the updating unit reads the history of the playback start position and the playback stop position from the recording medium, before updating the menu.

19. The playback apparatus of Claim 1 including a server apparatus and a client apparatus that are connected via a network,

the server apparatus including: a sending unit operable to send the menu and the set of video content to the client apparatus; and the updating unit,

the client apparatus including: the displaying unit; and the playback unit,

wherein the displaying unit in the client apparatus displays the menu sent from the server apparatus,

the playback unit in the client apparatus plays back the set of video content sent from the server apparatus, keeps the history of the playback start position and the playback stop position, and sends the history to the server apparatus,

the updating unit in the server apparatus updates the menu by placing the thumbnail of each piece of picture data chosen from between the playback start position and the playback stop position in the menu, according to the

history sent from the client apparatus,

the sending unit in the server apparatus sends the updated menu to the client apparatus, and

the displaying unit in the client apparatus displays  
5 the updated menu sent from the server apparatus.

20. A computer-readable program which has a computer play back video content that includes a plurality of pieces of picture data, comprising:

10 a displaying step of displaying a menu which lists a plurality of sets of video content;

a playback step of playing back one of the plurality of sets of video content which is selected from the menu by a user, and keep a history of a playback start position  
15 and a playback stop position; and

an updating step of updating the menu and having the displaying step display the updated menu, after the playback by the playback step,

wherein the update is performed by choosing at least  
20 one piece of picture data from between the playback start position and the playback stop position in the set of video content, and placing a thumbnail of each chosen piece of picture data in the menu.

25 21. The program of Claim 20,

wherein if another thumbnail already exists in the menu, the updating step places the thumbnail adjacent to the other thumbnail.

5           22. The program of Claim 21,

          wherein the playback by the playback step is a  $p$ th playback operation performed on the set of video content,  $p$  being an integer no smaller than 2, and

          the other thumbnail is a thumbnail of a piece of  
10 picture data which is located between a playback start position and a playback stop position of a  $(p-1)$ th playback operation performed on the set of video content.

          23. The program of Claim 20,

15           wherein a number of thumbnails which the updating step places in the menu depends on a ratio of a playback time length from the playback start position to the playback stop position to a total playback time length of the set of video content.

20

          24. The program of Claim 23,

          wherein the menu has a plurality of navigation areas which are in a one-to-one correspondence with the plurality of sets of video content,

25           each navigation area is given an upper limit to a

number of placeable thumbnails, and

the number of thumbnails which the updating step places in a navigation area corresponding to the set of video content is a number obtained by multiplying an upper  
5 limit given to the navigation area by the ratio.

25. The program of Claim 24,

wherein each chosen piece of picture data is one of a plurality of pieces of picture data that are present  
10 at intervals of  $\Delta t$  starting from a beginning of the set of video content and is located between the playback start position and the playback stop position, and

$\Delta t$  is a value obtained by dividing the total playback time length of the set of video content by the upper limit.

15

26. The program of Claim 25,

wherein each navigation area has the same upper limit to the number of placeable thumbnails.

20

27. The program of Claim 20,

wherein each chosen piece of picture data is present at intervals of  $\Delta t$  starting from the playback start position, and

$\Delta t$  is a value obtained by dividing a playback time  
25 length from the playback start position to the playback

stop position by a predetermined value.

28. The program of Claim 27,  
wherein the menu has a plurality of navigation areas  
5 which are in a one-to-one correspondence with the  
plurality of sets of video content,  
each navigation area is given the same upper limit  
to a number of placeable thumbnails, and  
the predetermined value is the same upper limit.

10

29. The program of Claim 20,  
wherein if another thumbnail already exists in the  
menu, the updating step places the thumbnail after  
deleting the other thumbnail.

15

30. The program of Claim 29,  
wherein the playback by the playback step is a  $p$ th  
playback operation performed on the set of video content,  
 $p$  being an integer no smaller than 2, and

20

the other thumbnail is a thumbnail of a piece of  
picture data which is located between a playback start  
position and a playback stop position of a  $(p-1)$ th playback  
operation performed on the set of video content.

25

31. The program of Claim 20,

wherein the at least one piece of picture data chosen in the updating step is a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from the playback start position, and

5         $\Delta t$  is shorter near the playback stop position than near the playback start position.

32. The program of Claim 20,

wherein the at least one piece of picture data chosen  
10 in the updating step is a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from the playback start position, and

$\Delta t$  is shorter near the playback start position than near the playback stop position.

15

33. The program of Claim 20,

wherein the updating step chooses a plurality of pieces of picture data from between the playback start position and the playback stop position, and places a  
20 plurality of thumbnails of the respective plurality of pieces of picture data one after another in the menu so that the plurality of thumbnails are displayed like a slide show.

25

34. The program of Claim 33,

wherein each chosen piece of picture data is one of a plurality of pieces of picture data that are present at intervals of  $\Delta t$  starting from a beginning of the set of video content and is located between the playback start position and the playback stop position.

35. The program of Claim 20,

wherein the playback start position is a beginning of the set of video content or a position where the user requests to resume playing back the set of video content,  
10 and

the playback stop position is a position where the user requests to stop playing back the set of video content or an end of the set of video content.

15 36. The program of Claim 35,

wherein the playback stop position is a position where the user requests to switch from a normal playback mode to a special playback mode, and

the playback start position is a position where the user requests to switch from the special playback mode  
20 back to the normal playback mode.

37. The program of Claim 20, further comprising:  
a recording step of recording the plurality of sets



of video content on a recording medium,

wherein the playback step writes the history of the playback start position and the playback stop position into the recording medium, after playing back the set of video content recorded on the recording medium, and

the updating step reads the history of the playback start position and the playback stop position from the recording medium, before updating the menu.

10 38. The program of Claim 20,

wherein the computer includes a server computer and a client computer that are connected via a network,

the program further comprises:

a sending step of sending the menu and the set of video content to the client computer,

the server computer performs the sending step and the updating step,

the client computer performs the displaying step and the playback step,

20 wherein the displaying step in the client computer displays the menu sent from the server computer,

the playback step in the client computer plays back the set of video content sent from the server computer, keeps the history of the playback start position and the playback stop position, and sends the history to the server

computer,

the updating step in the server computer updates the menu by placing the thumbnail of each piece of picture data chosen from between the playback start position and the playback stop position in the menu, according to the  
5 history sent from the client computer,

the sending step in the server computer sends the updated menu to the client computer, and

the displaying step in the client computer displays  
10 the updated menu sent from the server computer.

39. A playback method for playing back video content that includes a plurality of pieces of picture data, comprising:

15 a displaying step of displaying a menu which lists a plurality of sets of video content;

a playback step of playing back one of the plurality of sets of video content which is selected from the menu by a user, and keep a history of a playback start position  
20 and a playback stop position; and

an updating step of updating the menu and having the displaying step display the updated menu, after the playback by the playback step,

wherein the update is performed by choosing at least  
25 one piece of picture data from between the playback start

position and the playback stop position in the set of video content, and placing a thumbnail of each chosen piece of picture data in the menu.

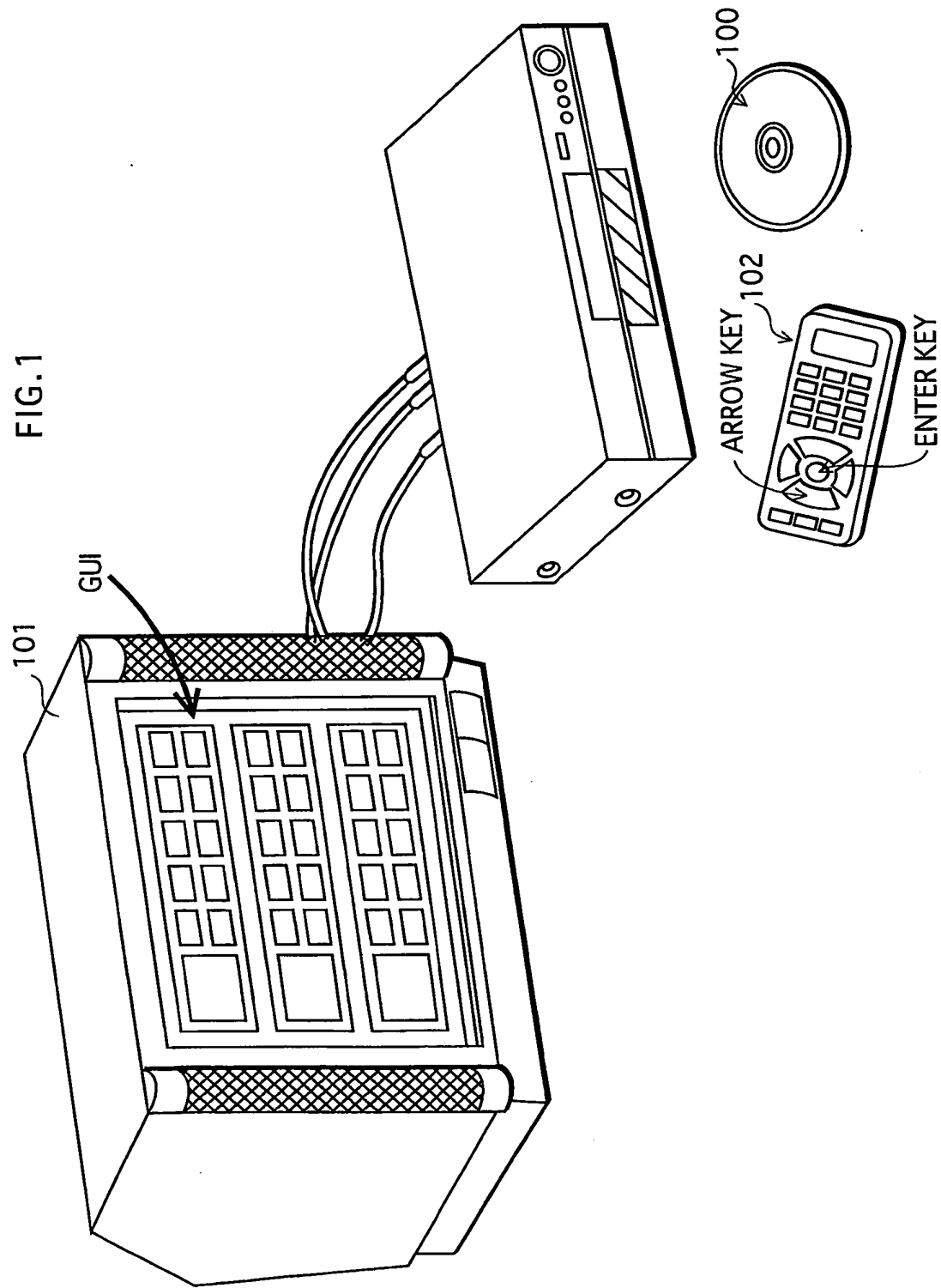


FIG. 2A

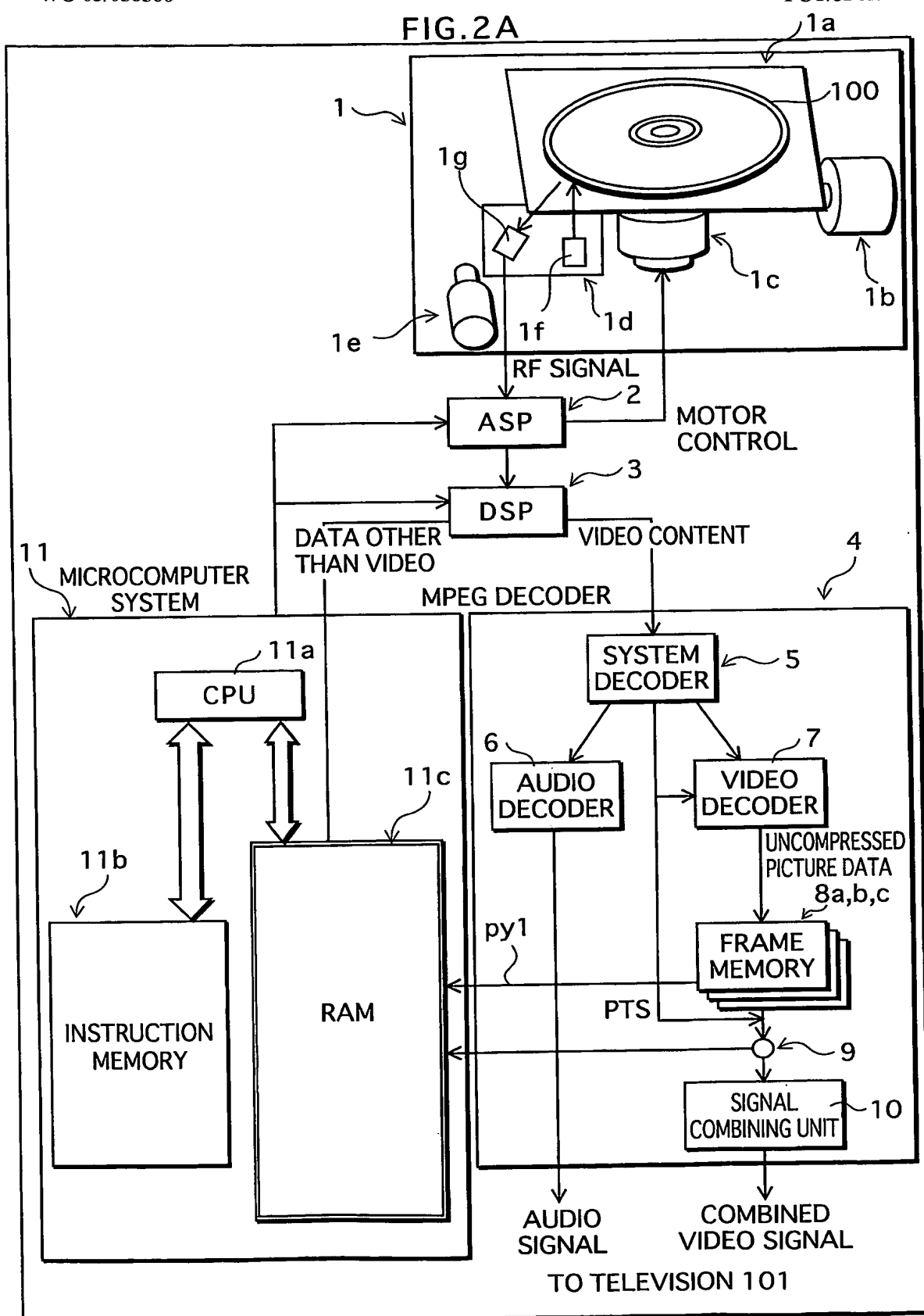


FIG. 2B

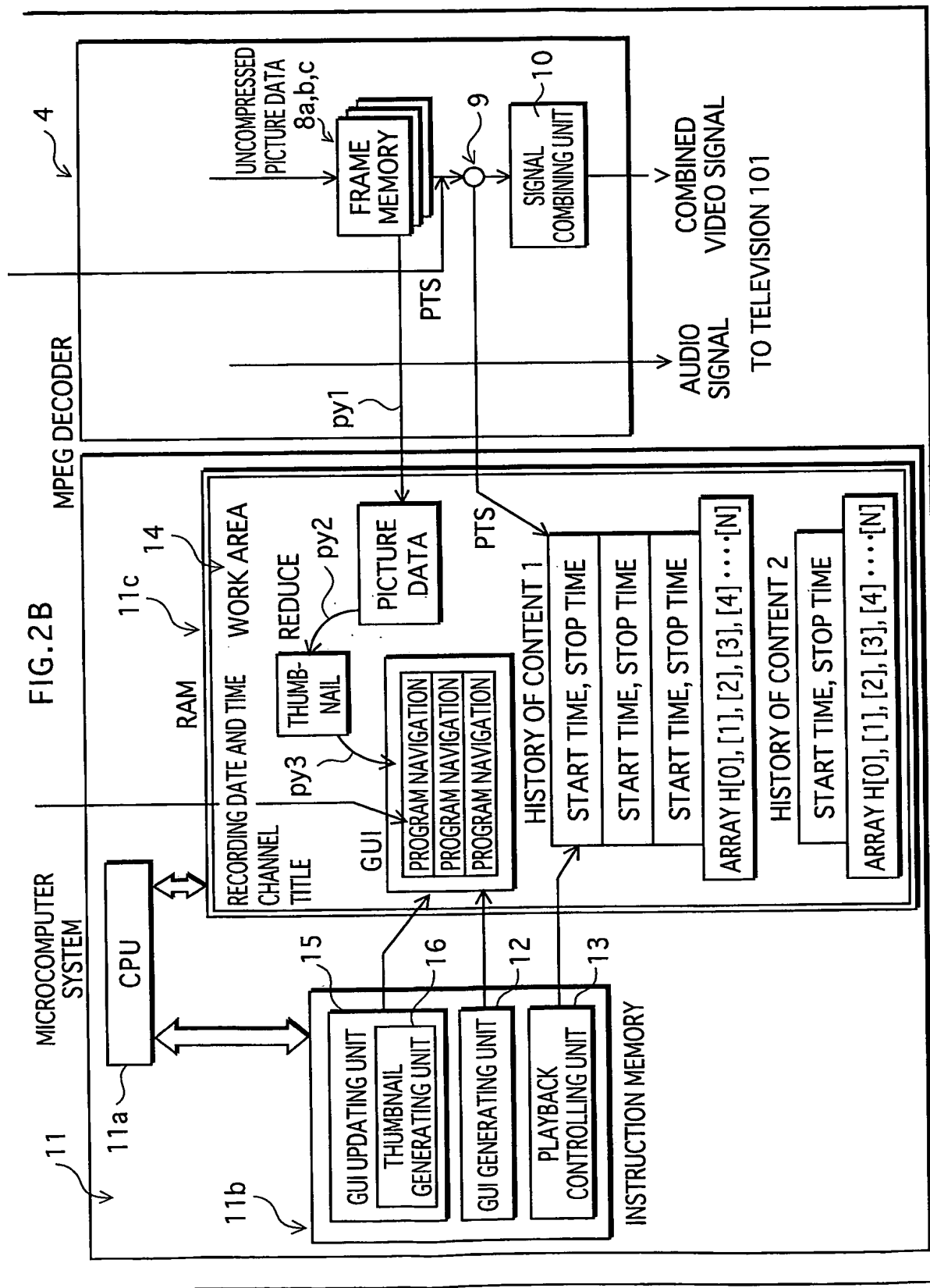


FIG. 3

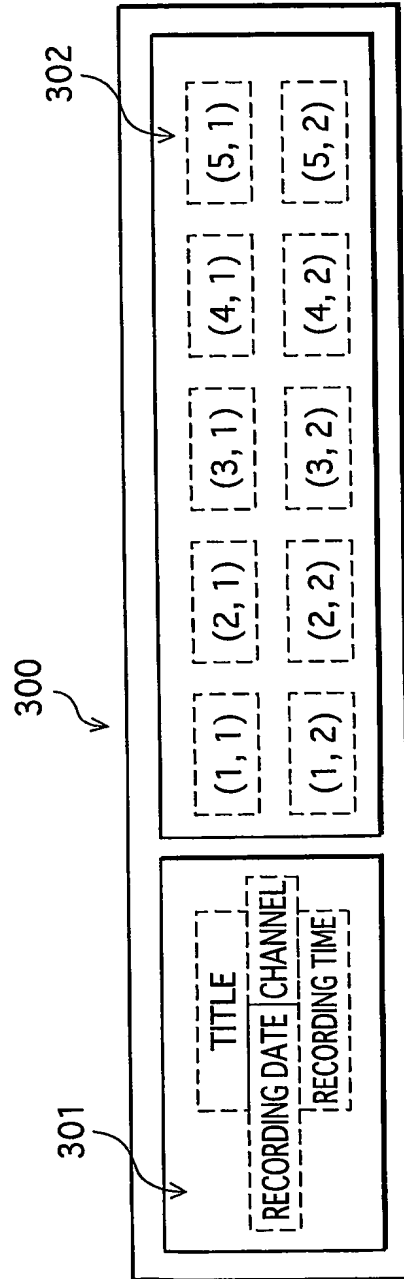


FIG. 4A

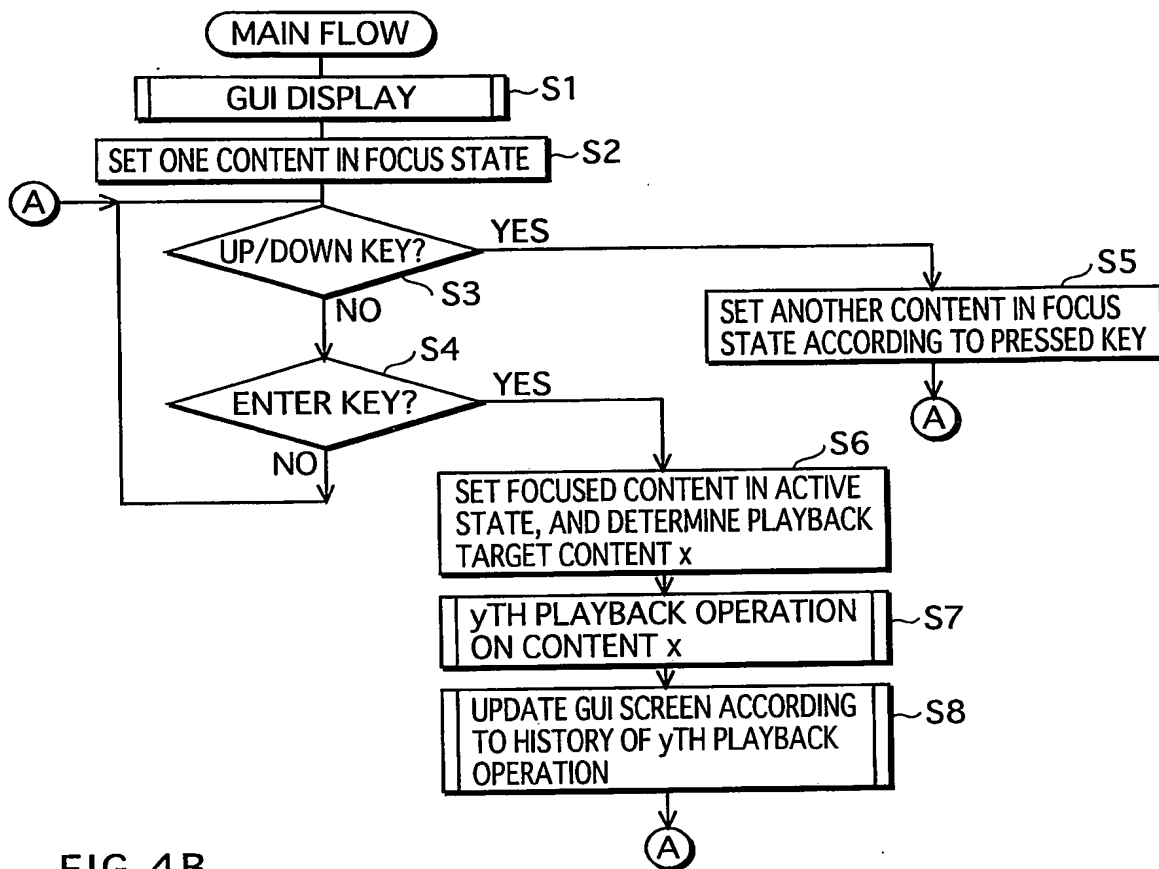


FIG. 4B

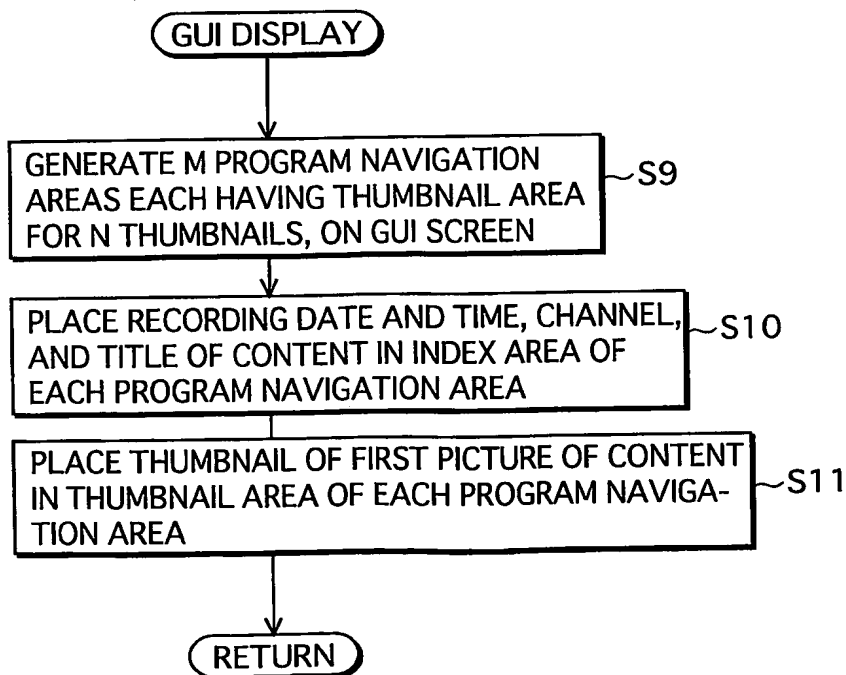




FIG. 5

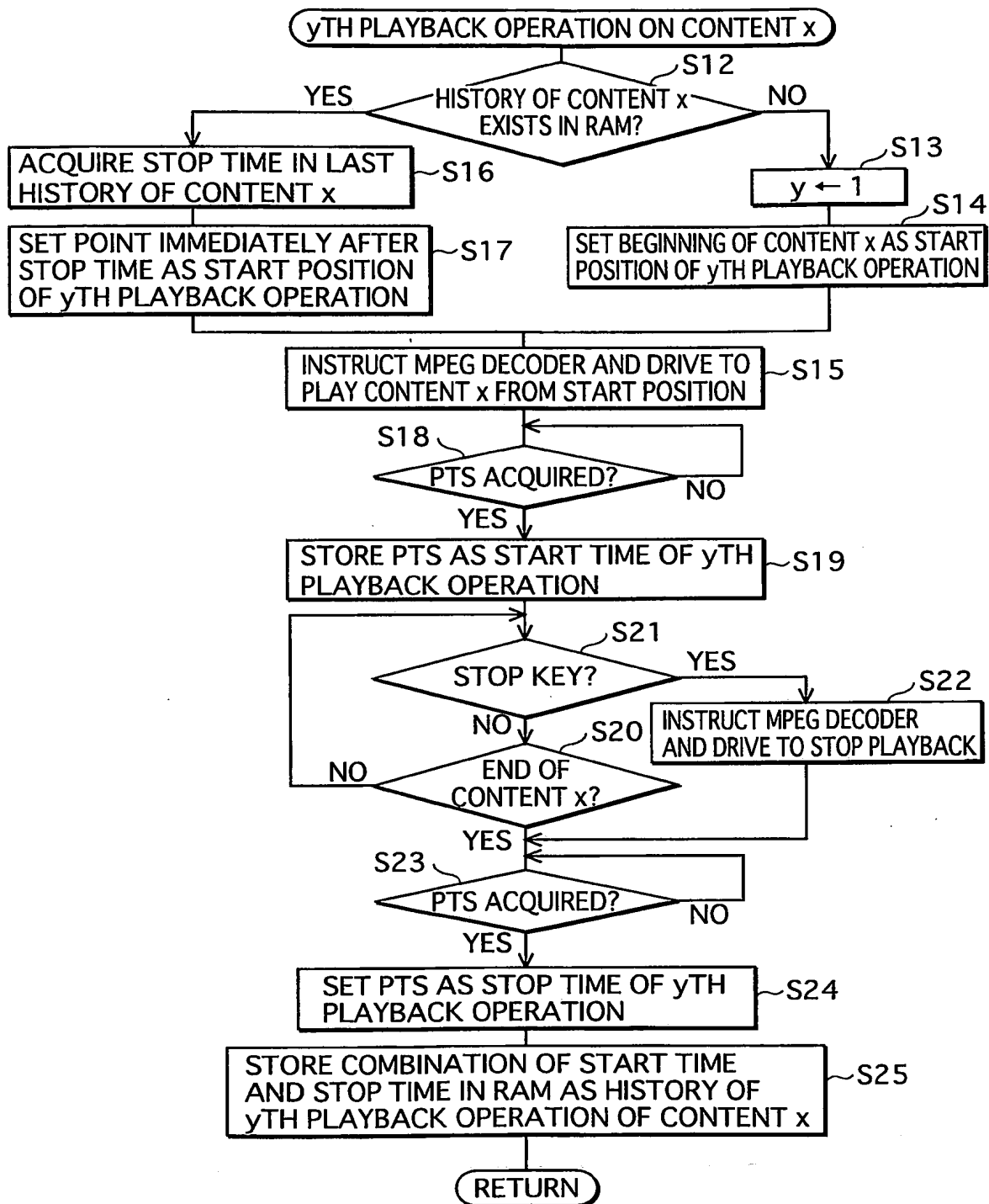


FIG. 6A

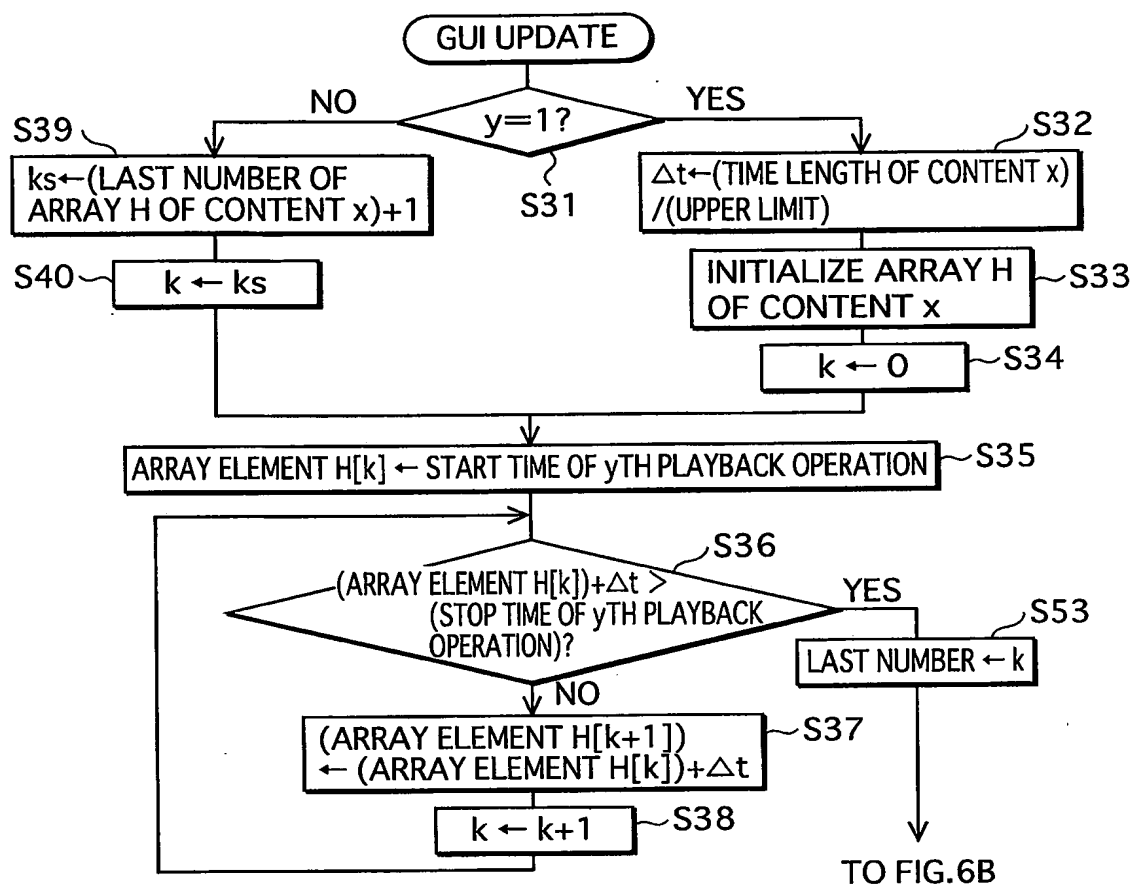


FIG. 6B

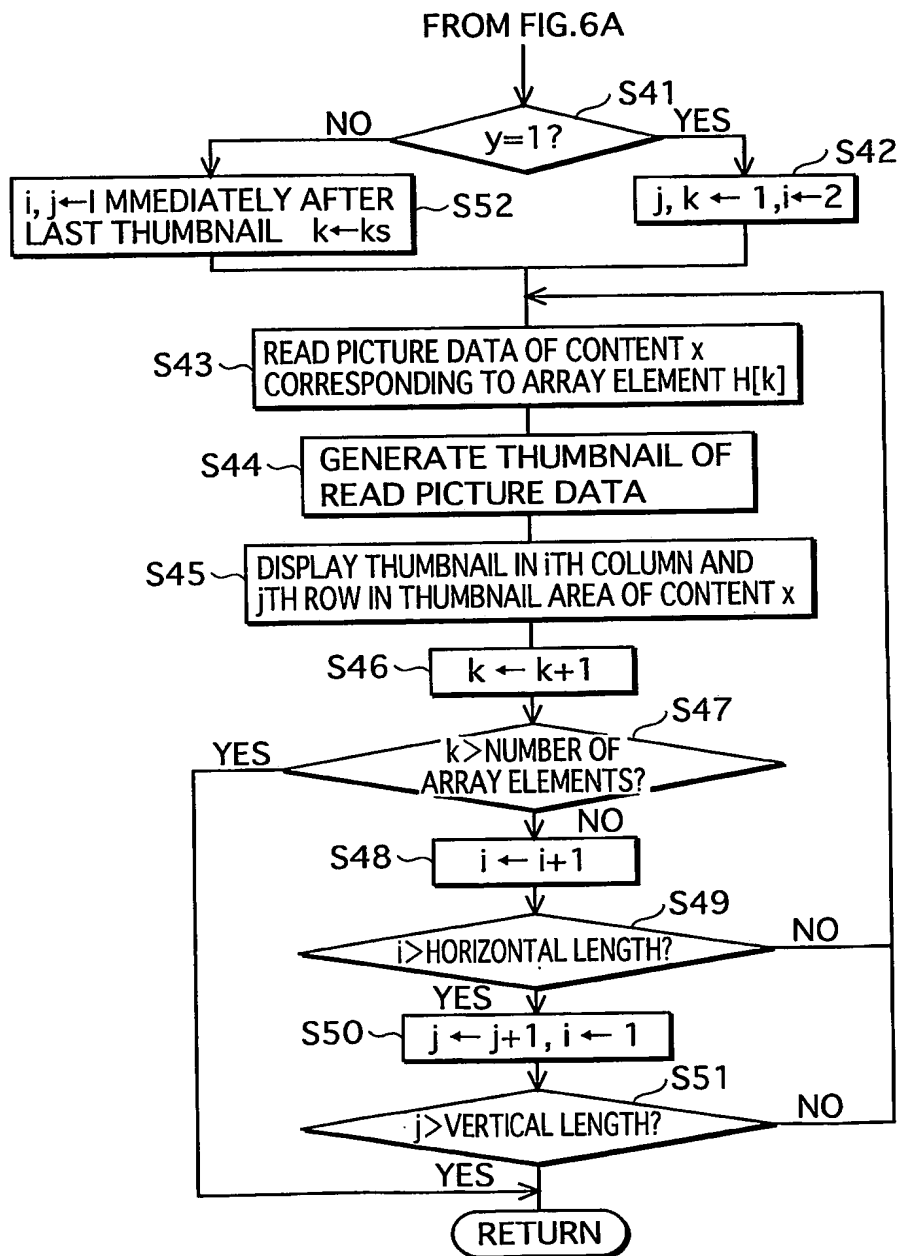


FIG.7

NO PLAYBACK OPERATIONS PERFORMED  
ON CONTENT 1 TO 3

CONTENT 1 2002 11/3 CH3 PM8:00~PM8:50	<div>0SEC</div>
CONTENT 2 2002 11/10 CH3 PM8:00~PM8:50	<div>0SEC</div>
CONTENT 3 2002 11/17 CH3 PM8:00~PM8:50	<div>0SEC</div>

FIG. 8

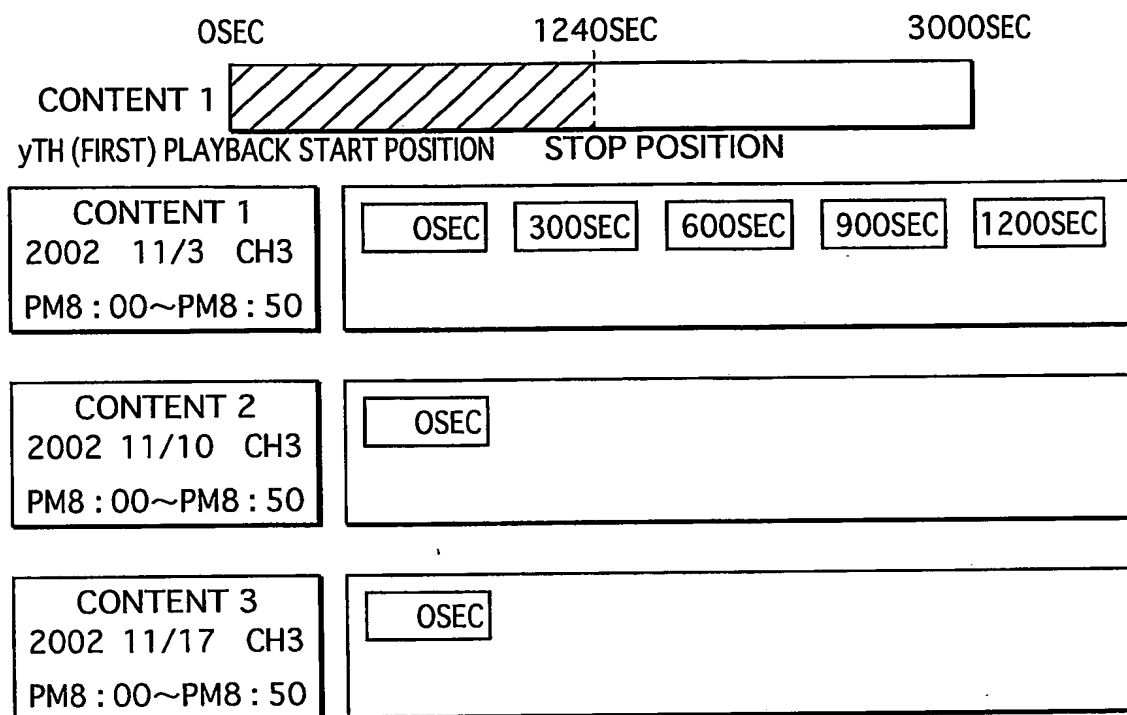


FIG.9

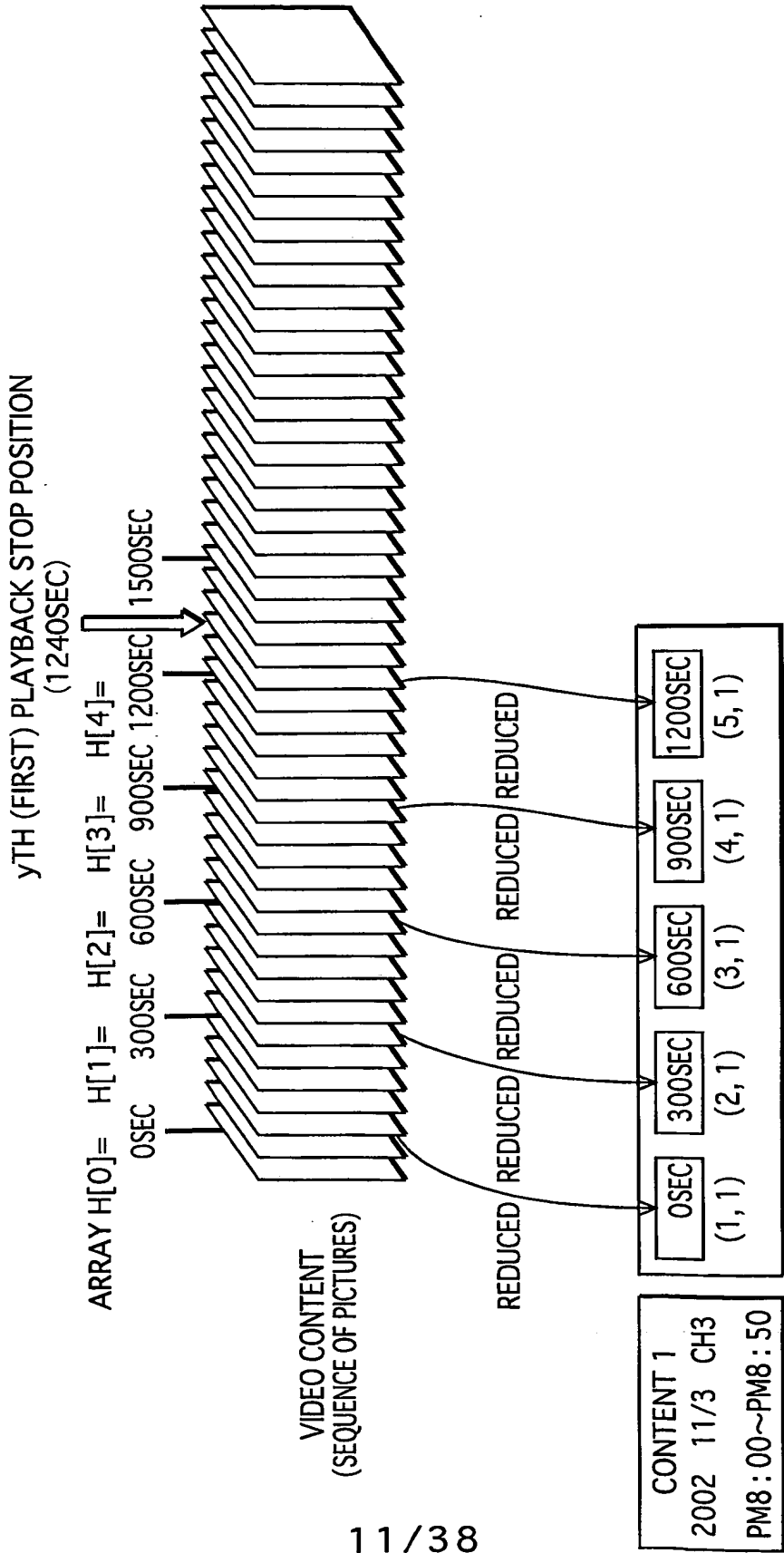


FIG.10

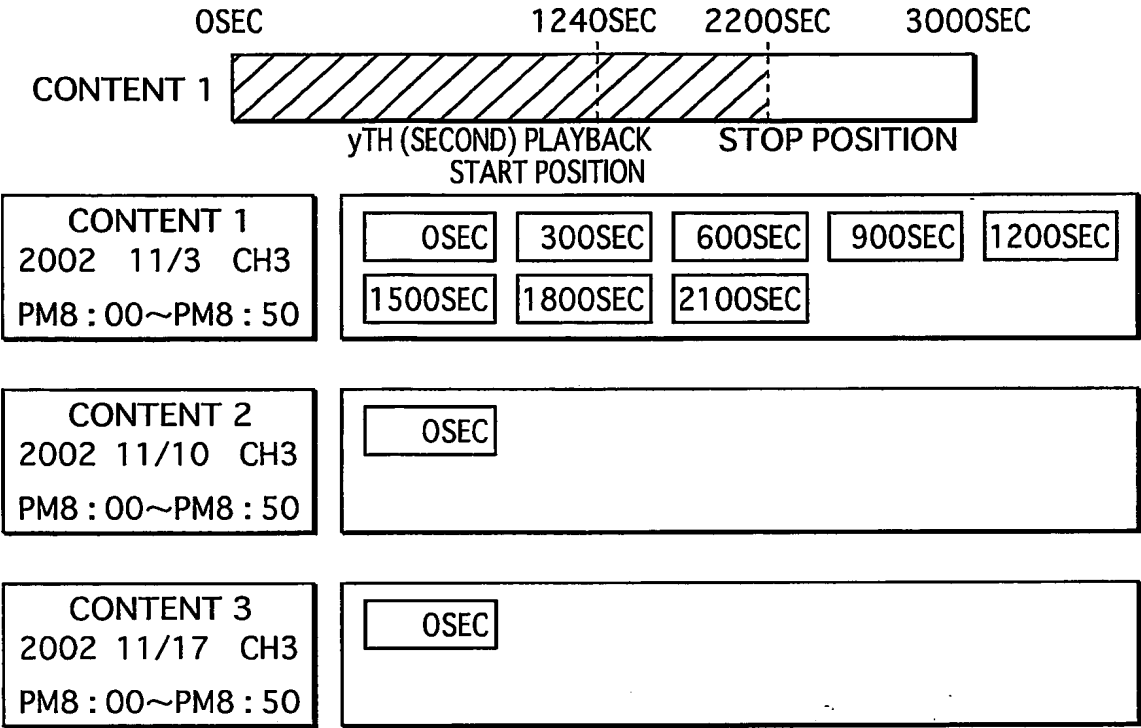


FIG. 11

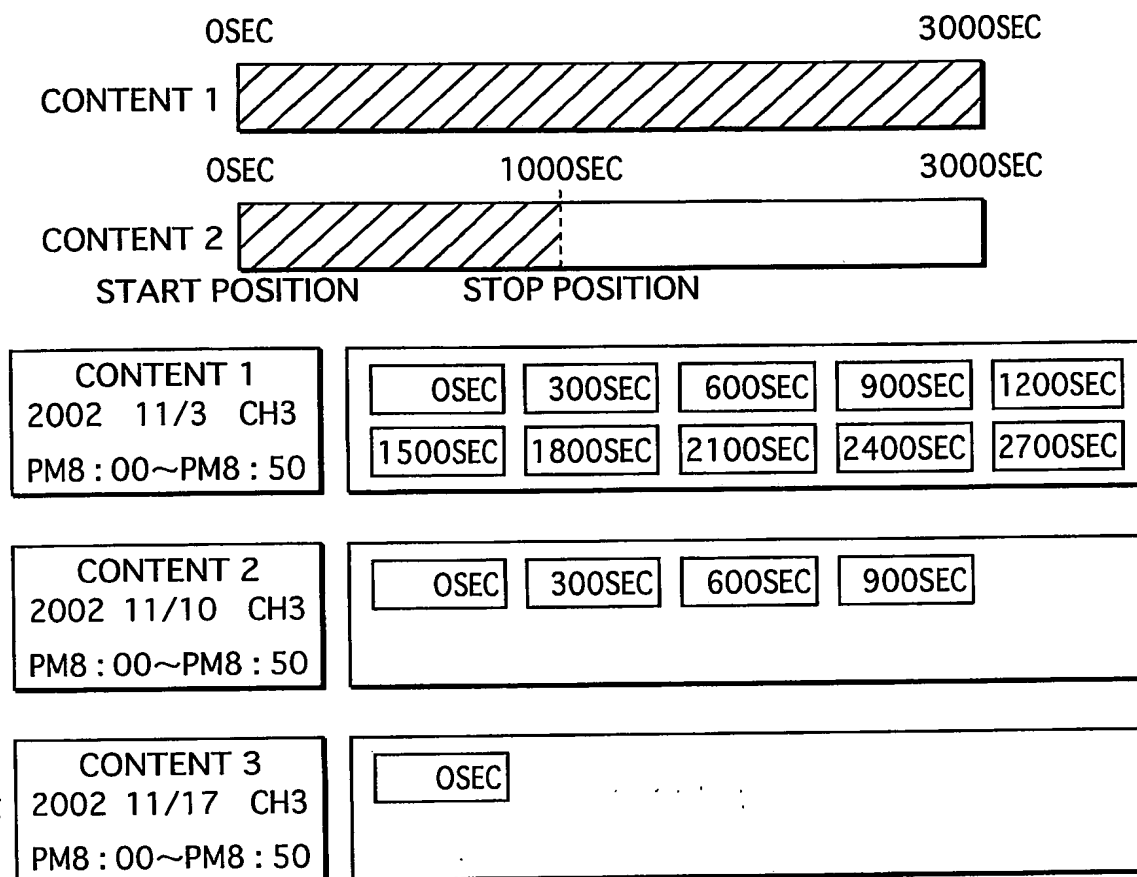




FIG.1 2

CONTENT 1 2002 11/3 CH3 PM8 : 00~PM8 : 50	<table><tr><td>0SEC</td><td>300SEC</td><td>600SEC</td><td>900SEC</td><td>1200SEC</td></tr><tr><td>1500SEC</td><td>1800SEC</td><td>2100SEC</td><td>2400SEC</td><td>2700SEC</td></tr></table>					0SEC	300SEC	600SEC	900SEC	1200SEC	1500SEC	1800SEC	2100SEC	2400SEC	2700SEC
0SEC	300SEC	600SEC	900SEC	1200SEC											
1500SEC	1800SEC	2100SEC	2400SEC	2700SEC											
CONTENT 2 2002 11/10 CH3 PM8 : 00~PM8 : 50	<table><tr><td>0SEC</td><td>300SEC</td><td>600SEC</td><td>900SEC</td><td>1200SEC</td></tr><tr><td>1500SEC</td><td>1800SEC</td><td>2100SEC</td><td>2400SEC</td><td>2700SEC</td></tr></table>					0SEC	300SEC	600SEC	900SEC	1200SEC	1500SEC	1800SEC	2100SEC	2400SEC	2700SEC
0SEC	300SEC	600SEC	900SEC	1200SEC											
1500SEC	1800SEC	2100SEC	2400SEC	2700SEC											
CONTENT 3 2002 11/17 CH3 PM8 : 00~PM8 : 50	<table><tr><td>0SEC</td><td>300SEC</td><td>600SEC</td><td>900SEC</td><td>1200SEC</td></tr><tr><td>1500SEC</td><td>1800SEC</td><td>2100SEC</td><td>2400SEC</td><td>2700SEC</td></tr></table>					0SEC	300SEC	600SEC	900SEC	1200SEC	1500SEC	1800SEC	2100SEC	2400SEC	2700SEC
0SEC	300SEC	600SEC	900SEC	1200SEC											
1500SEC	1800SEC	2100SEC	2400SEC	2700SEC											

FIG.13

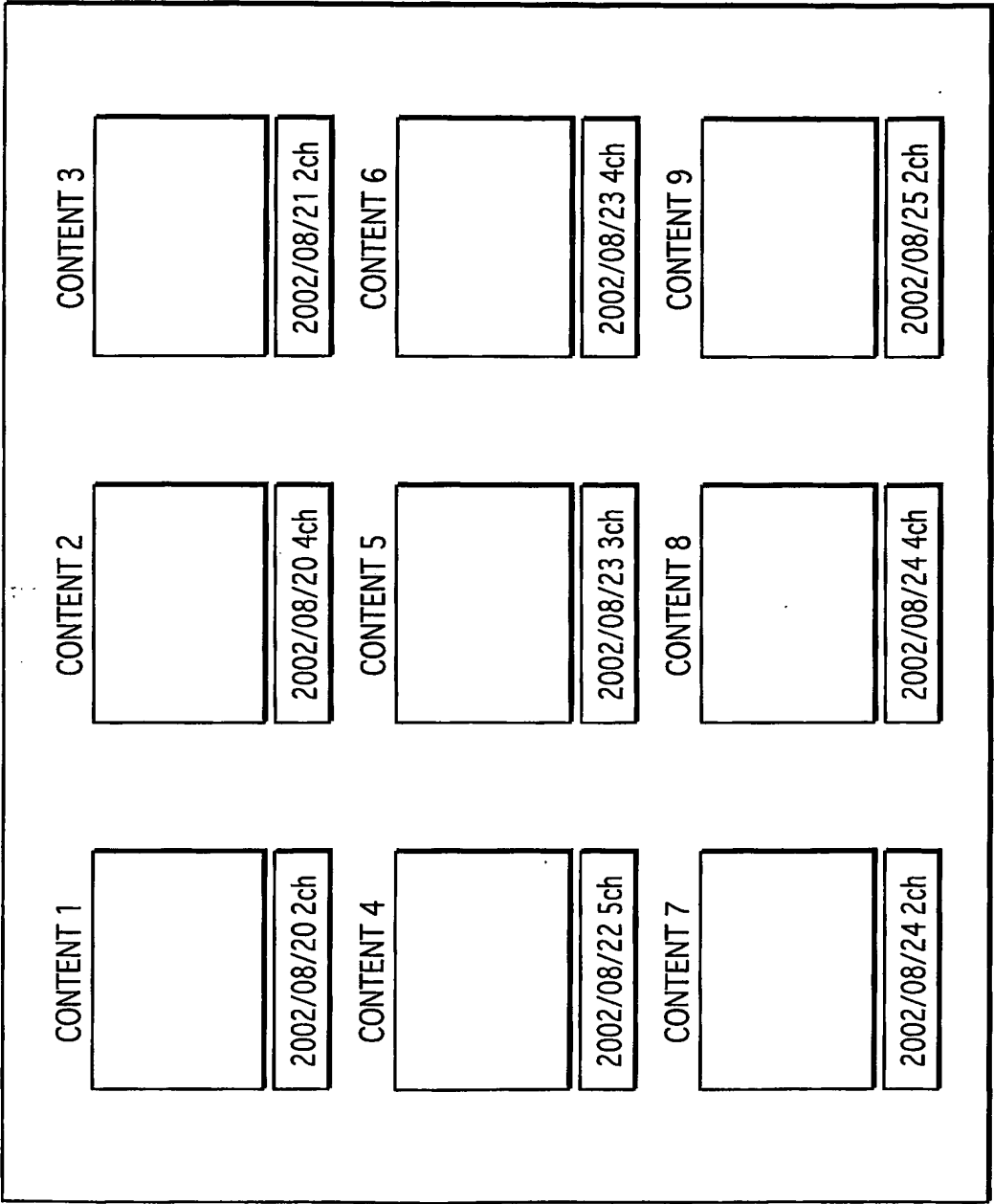


FIG. 14A

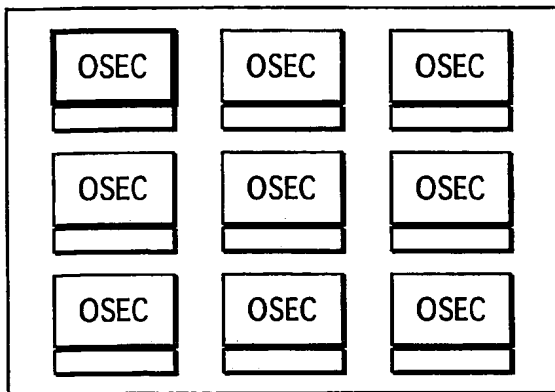


FIG. 14B

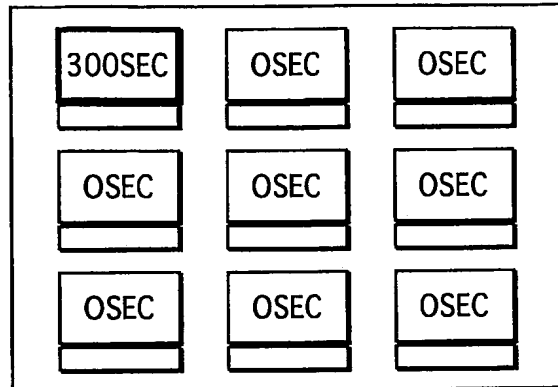


FIG. 14C

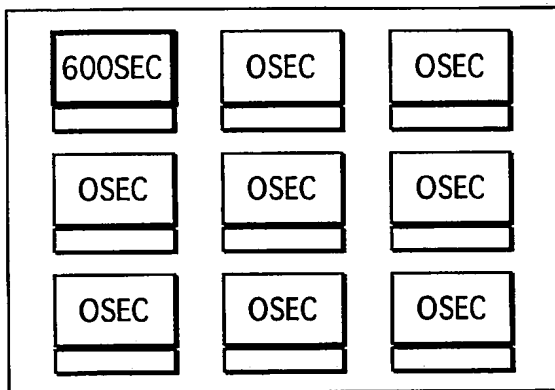


FIG. 14D

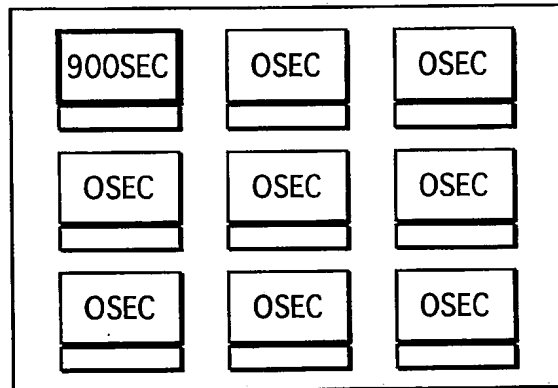


FIG. 14E

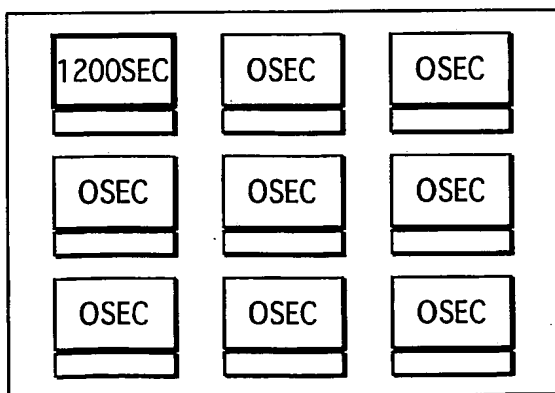


FIG. 14F

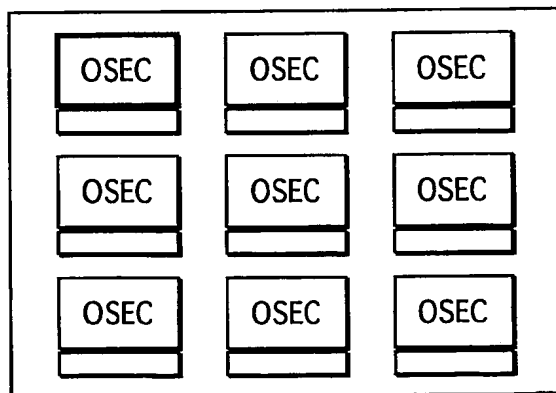


FIG.15A

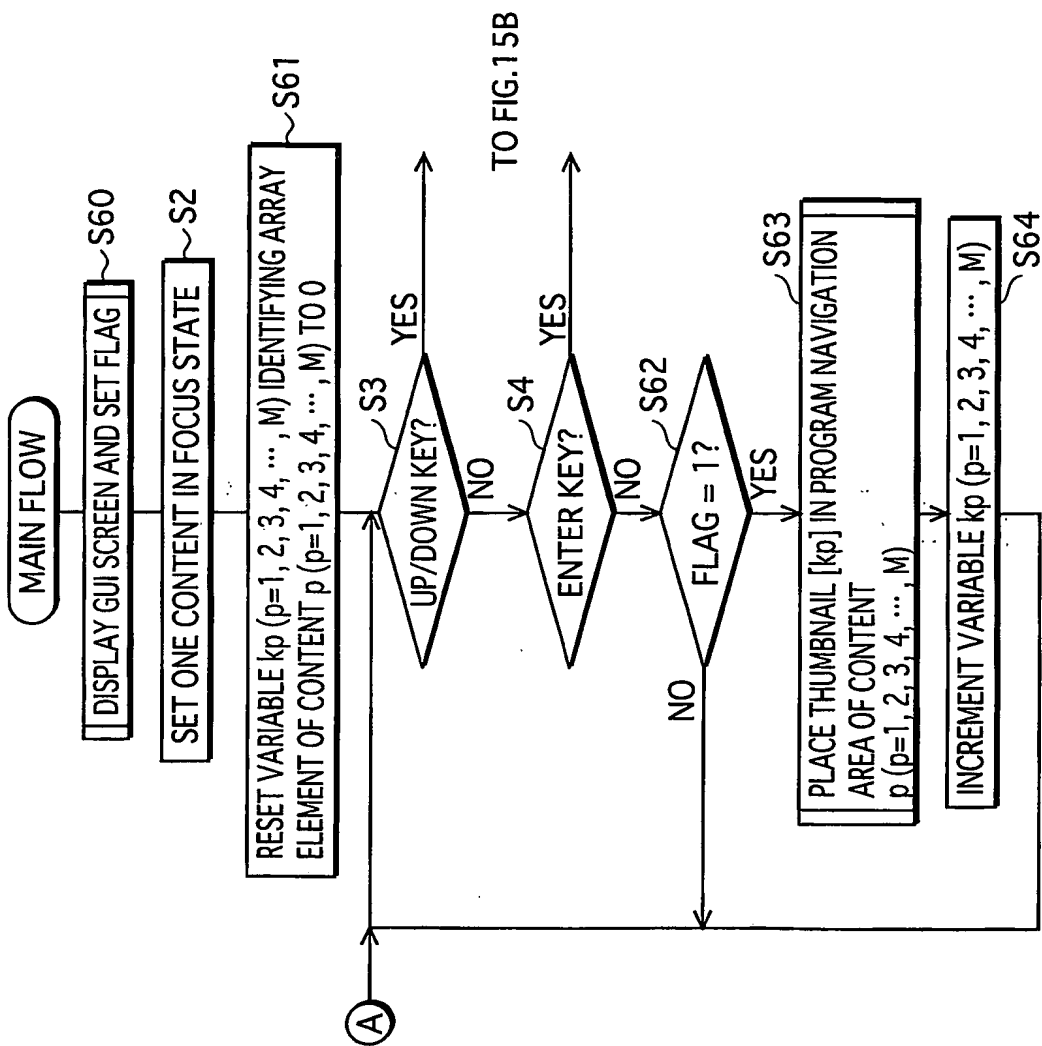


FIG. 15B

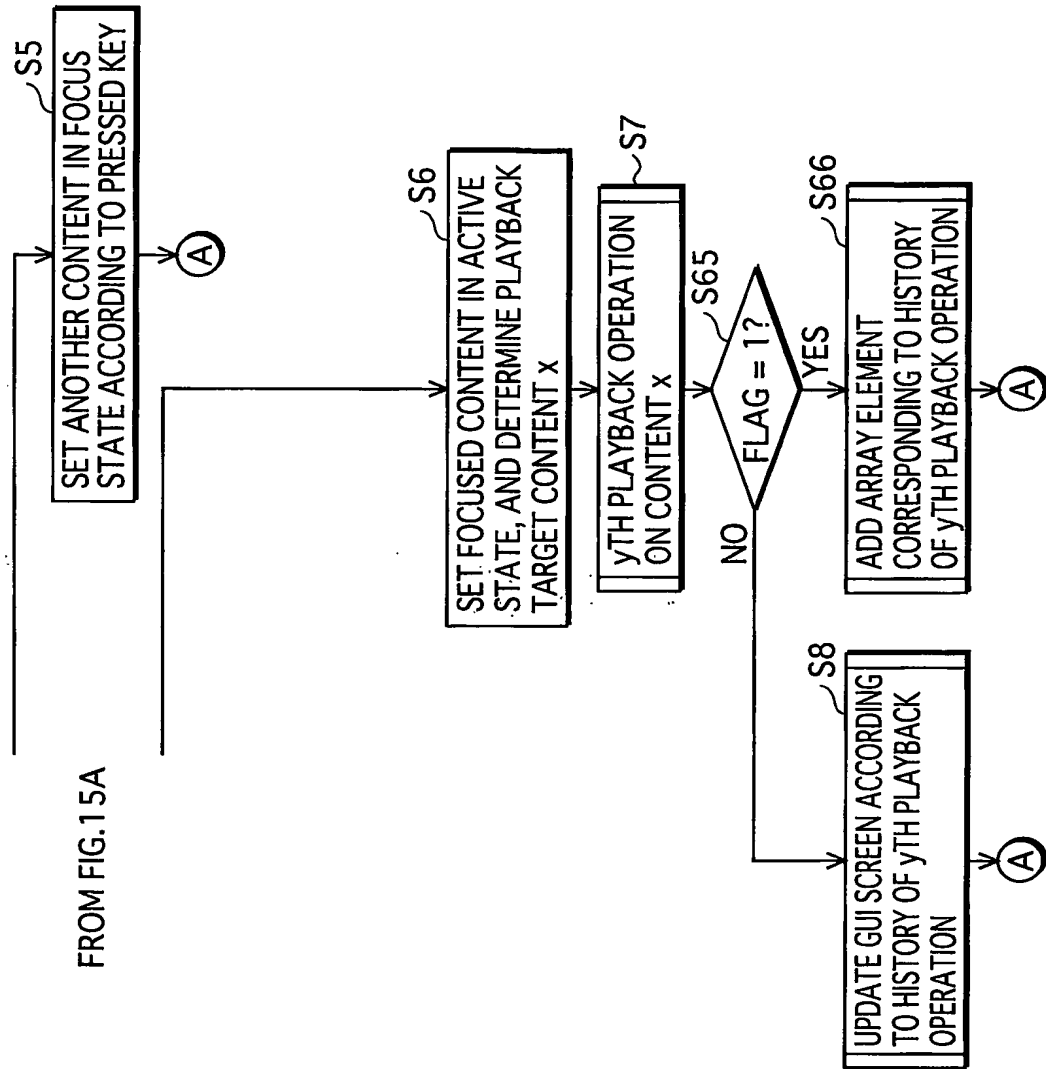


FIG. 16

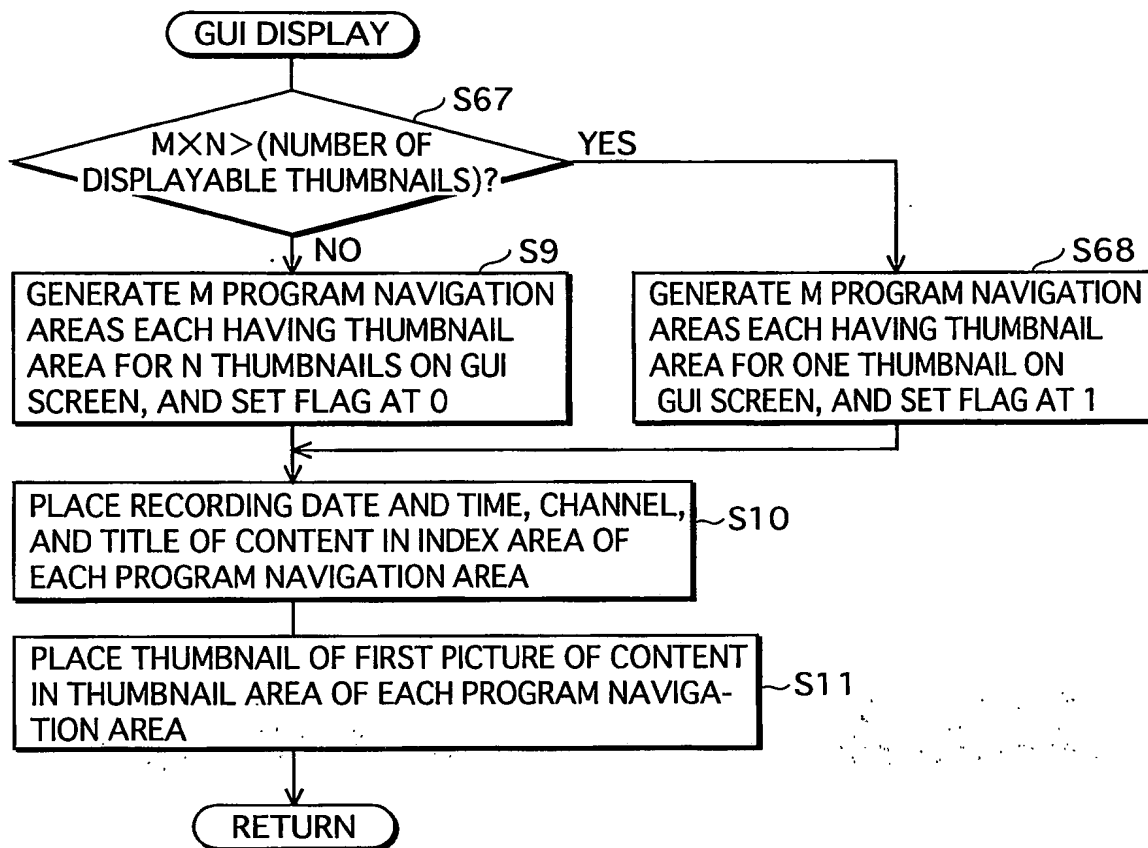


FIG.17

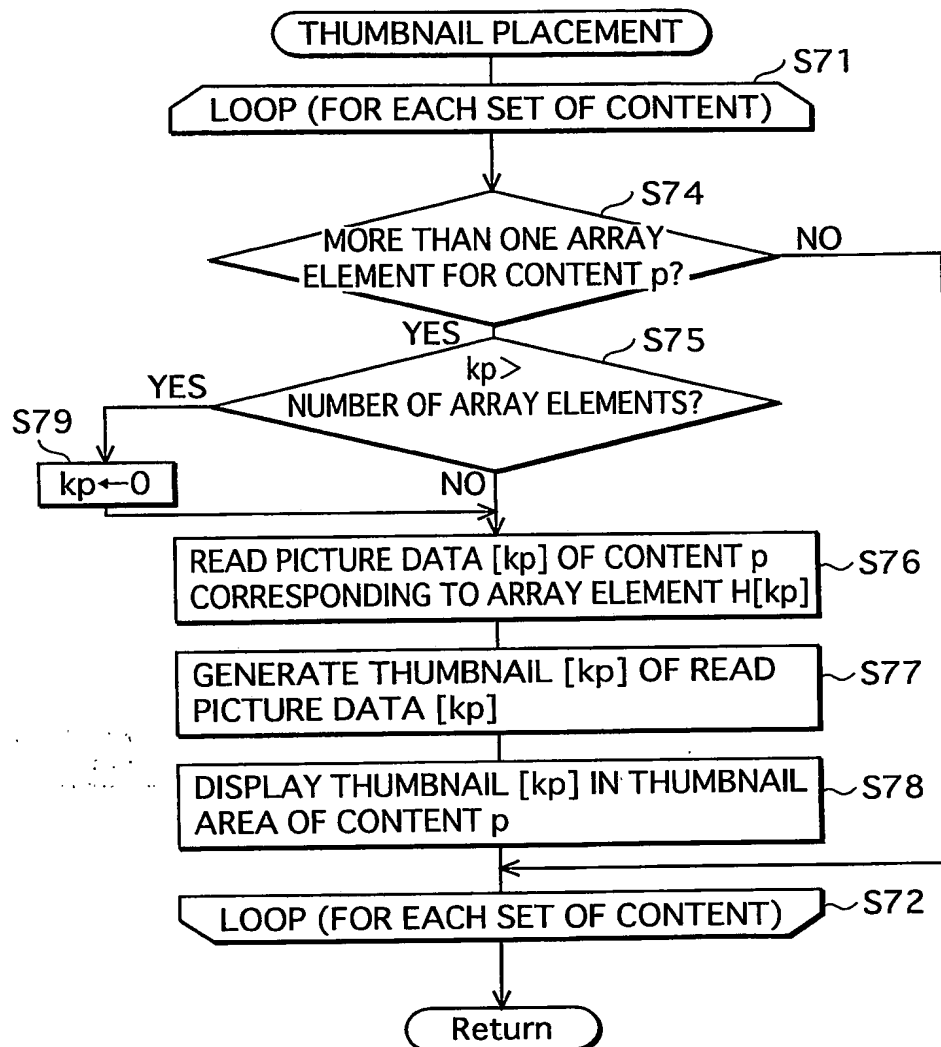


FIG. 18

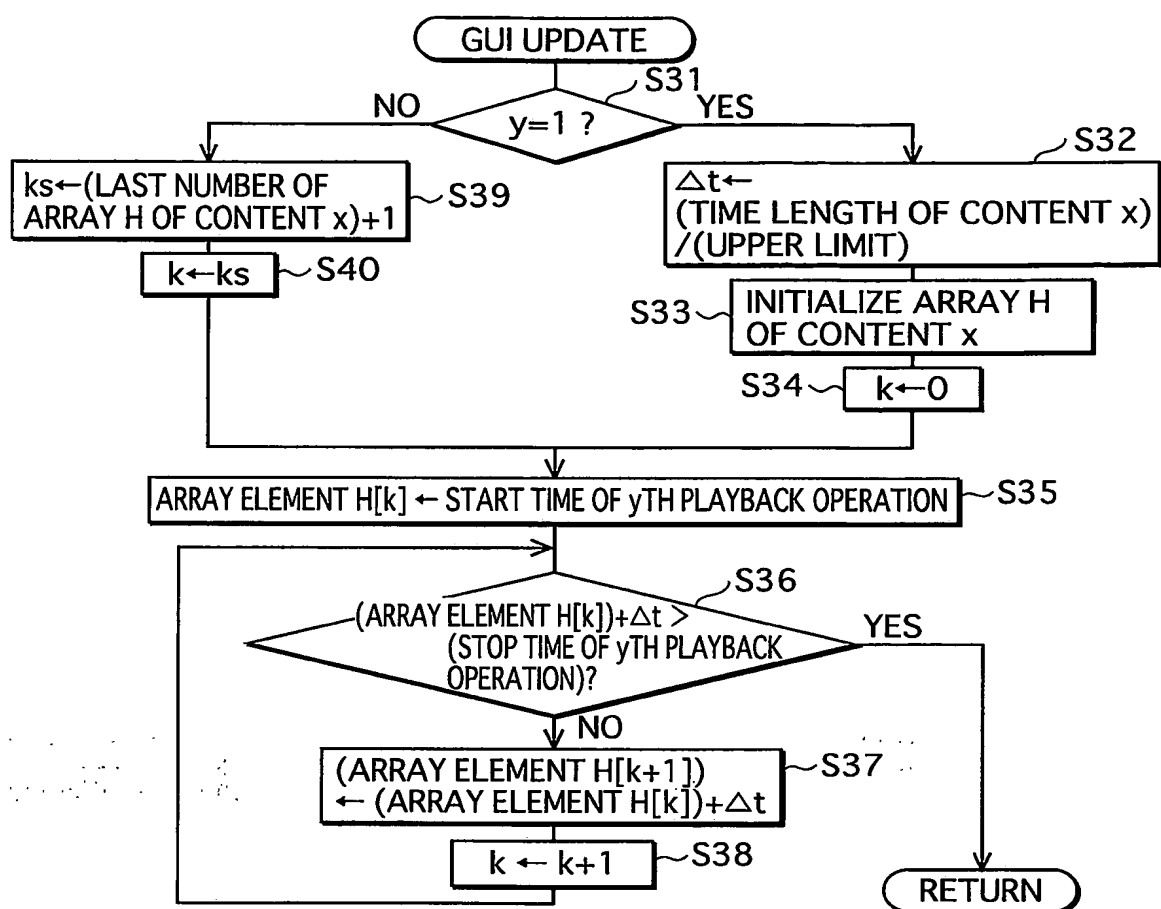






FIG.20

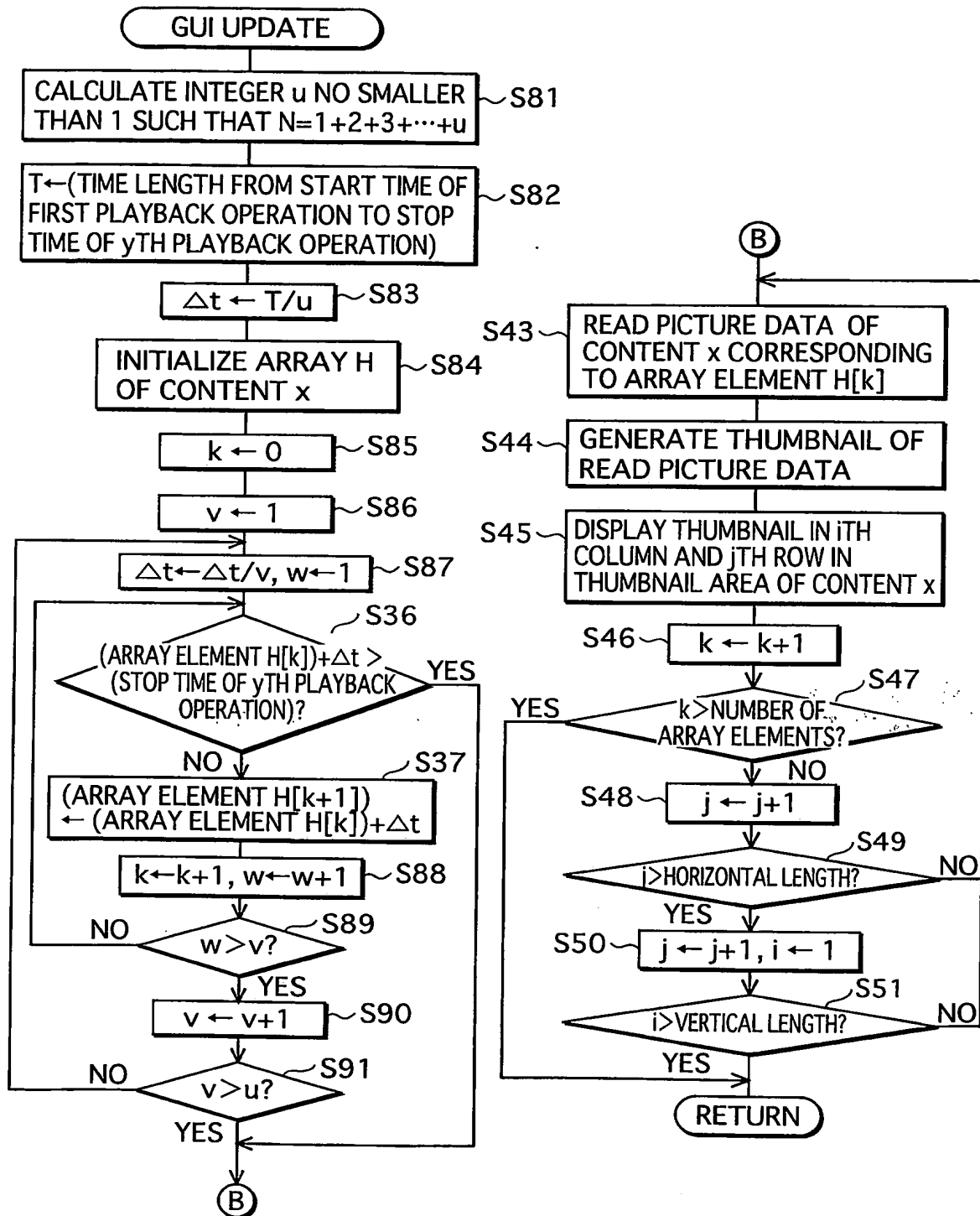






FIG. 23

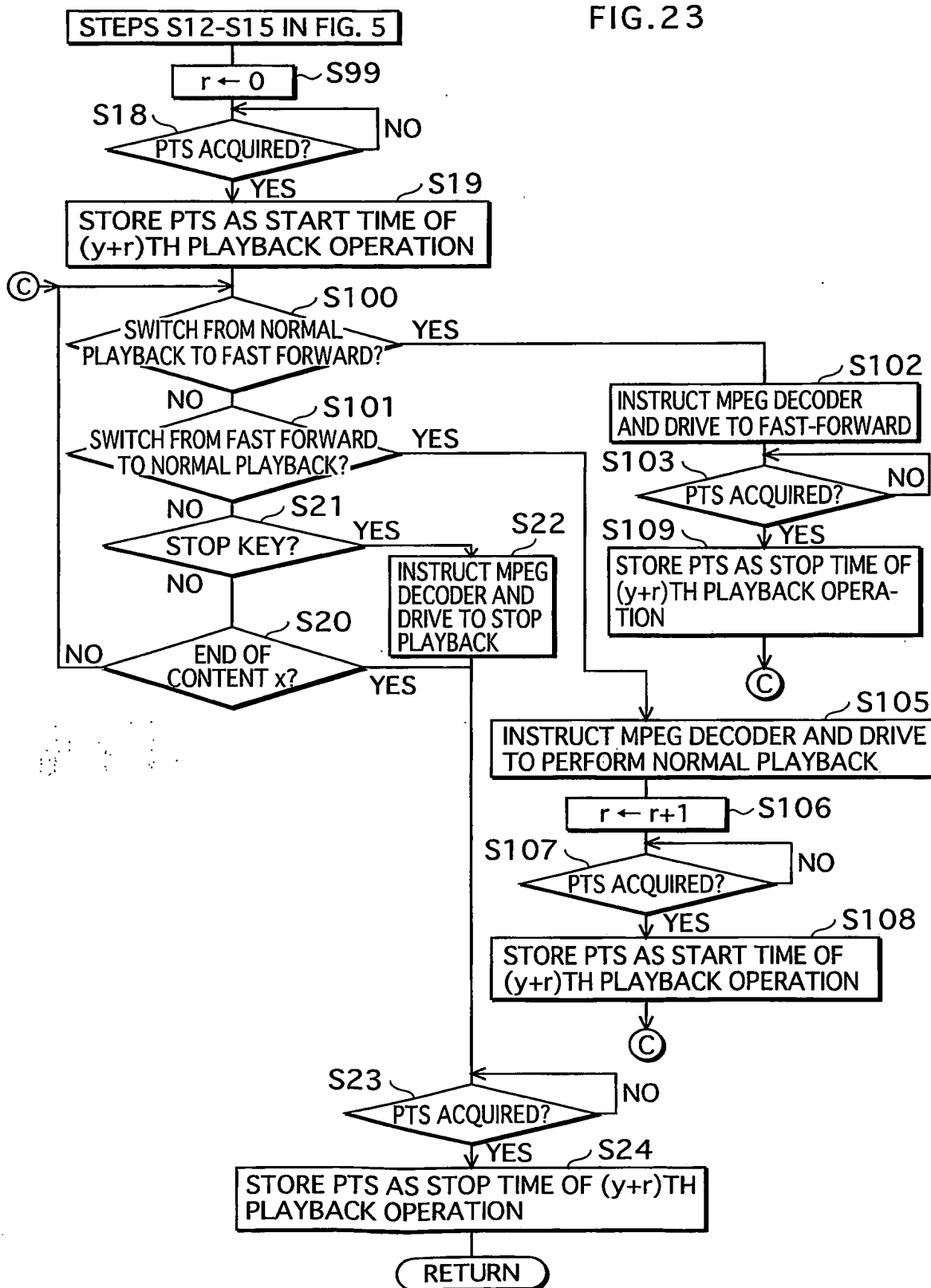


FIG.24

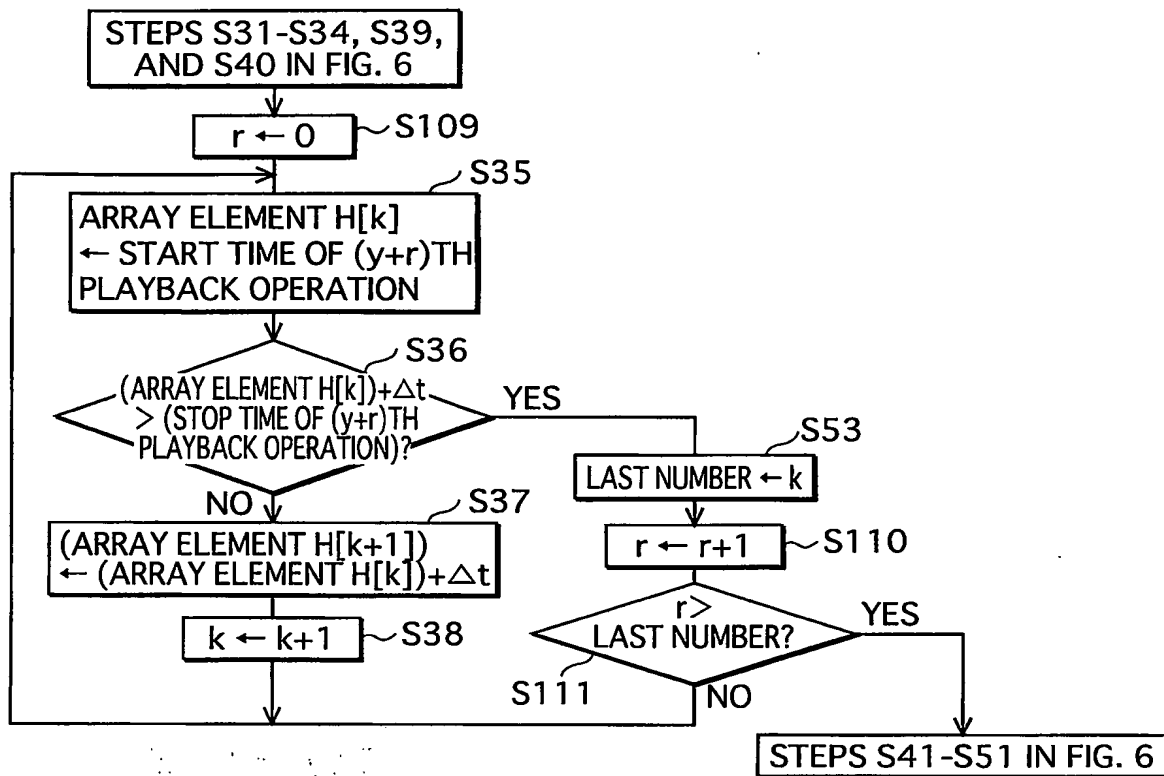


FIG. 25

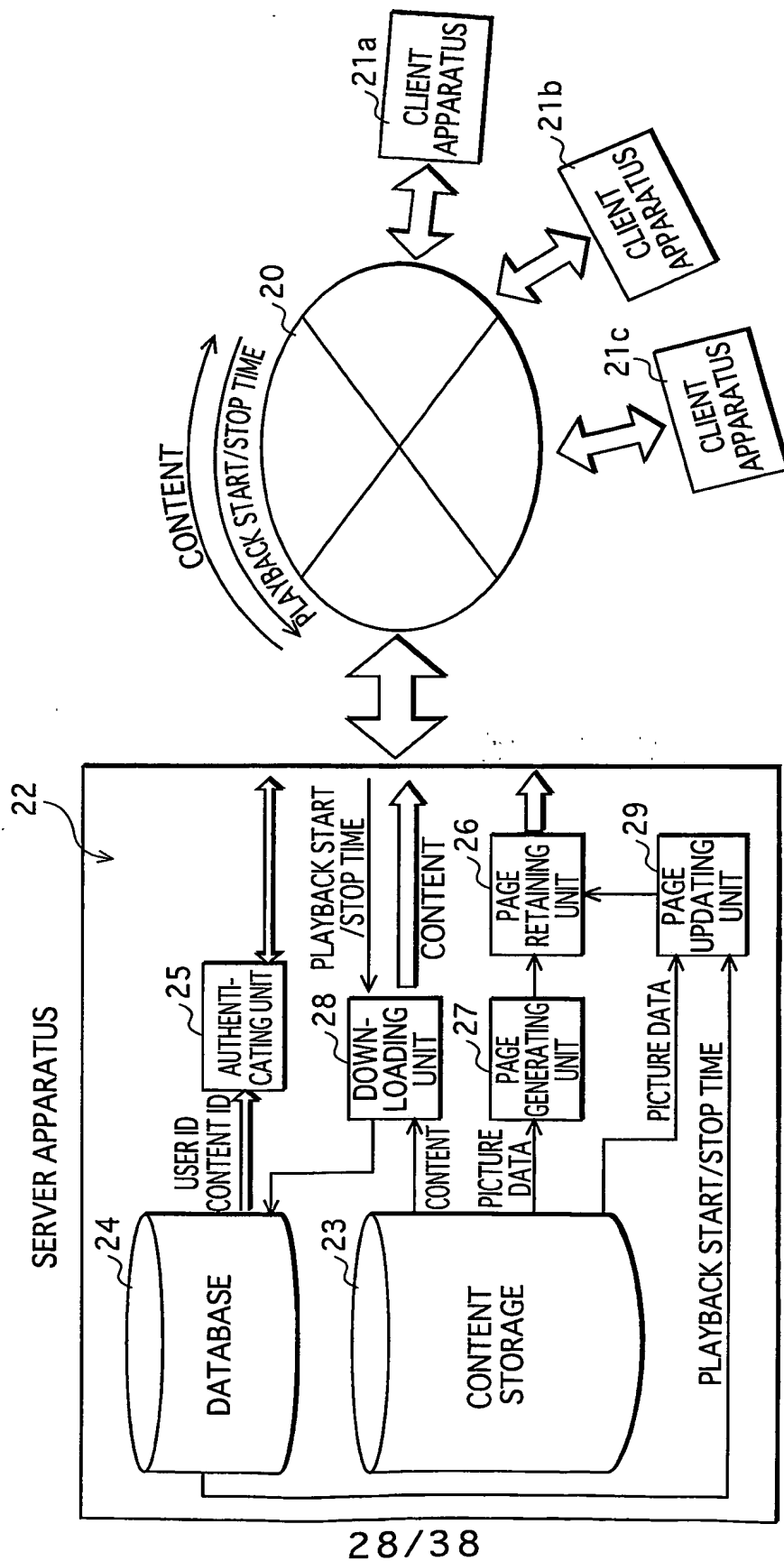


FIG.26

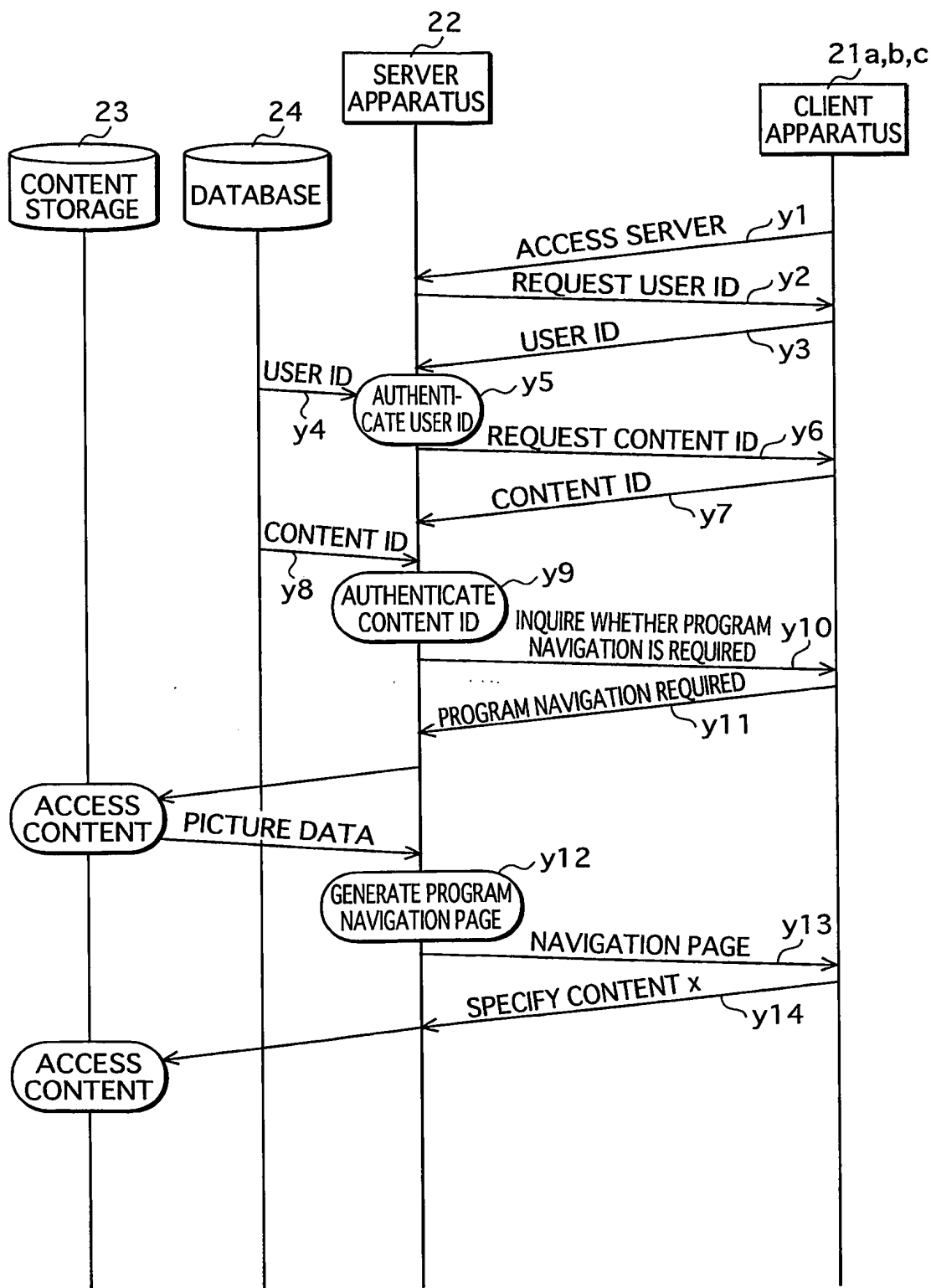




FIG.27

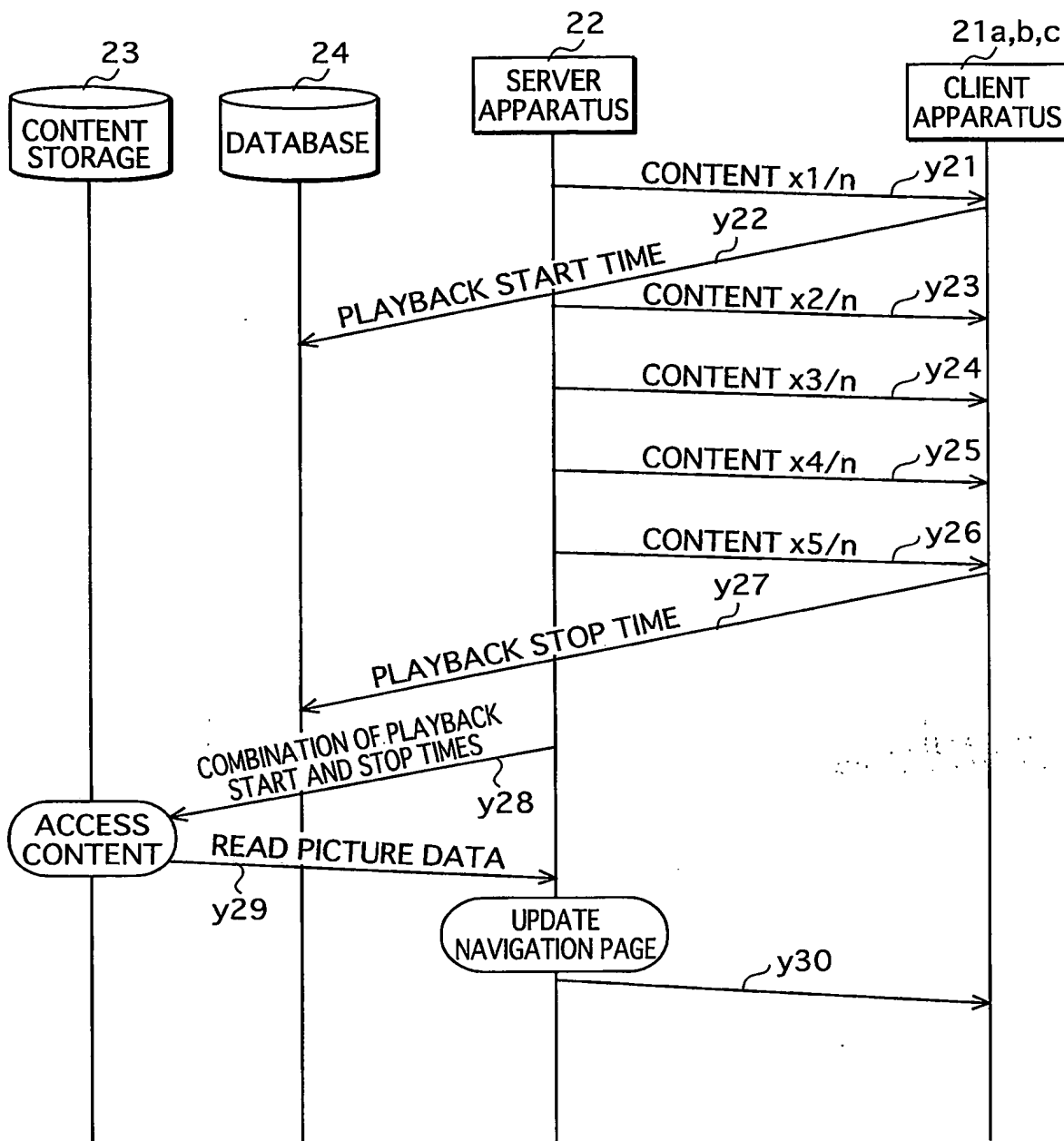


FIG.28

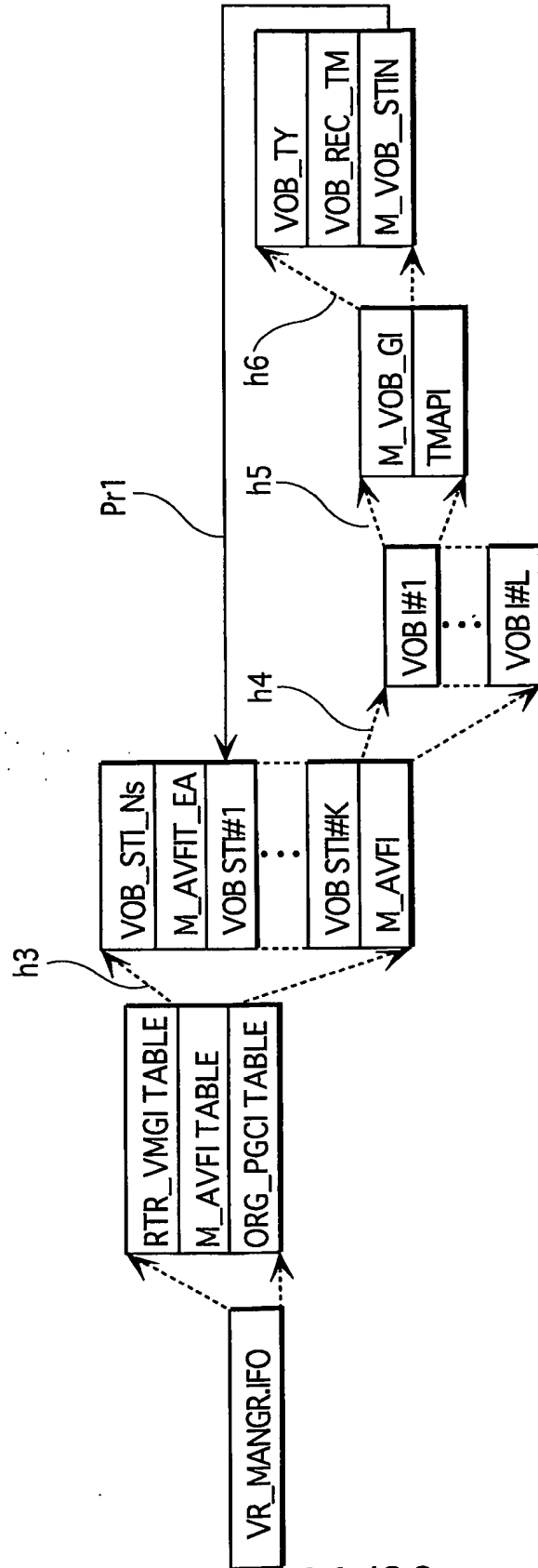


FIG.29

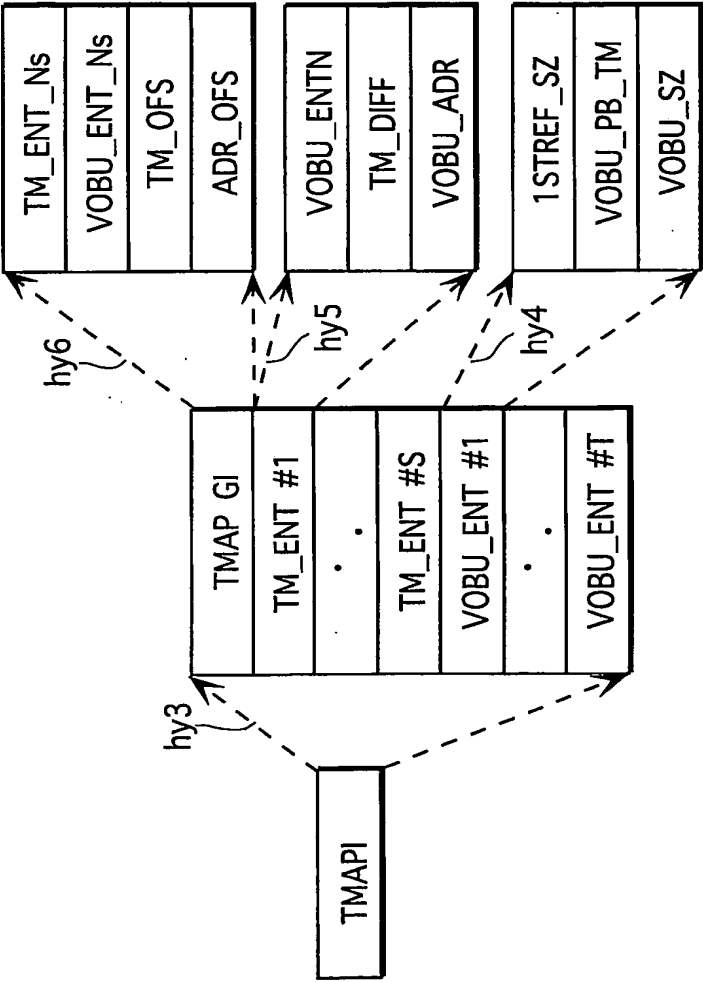




FIG.31

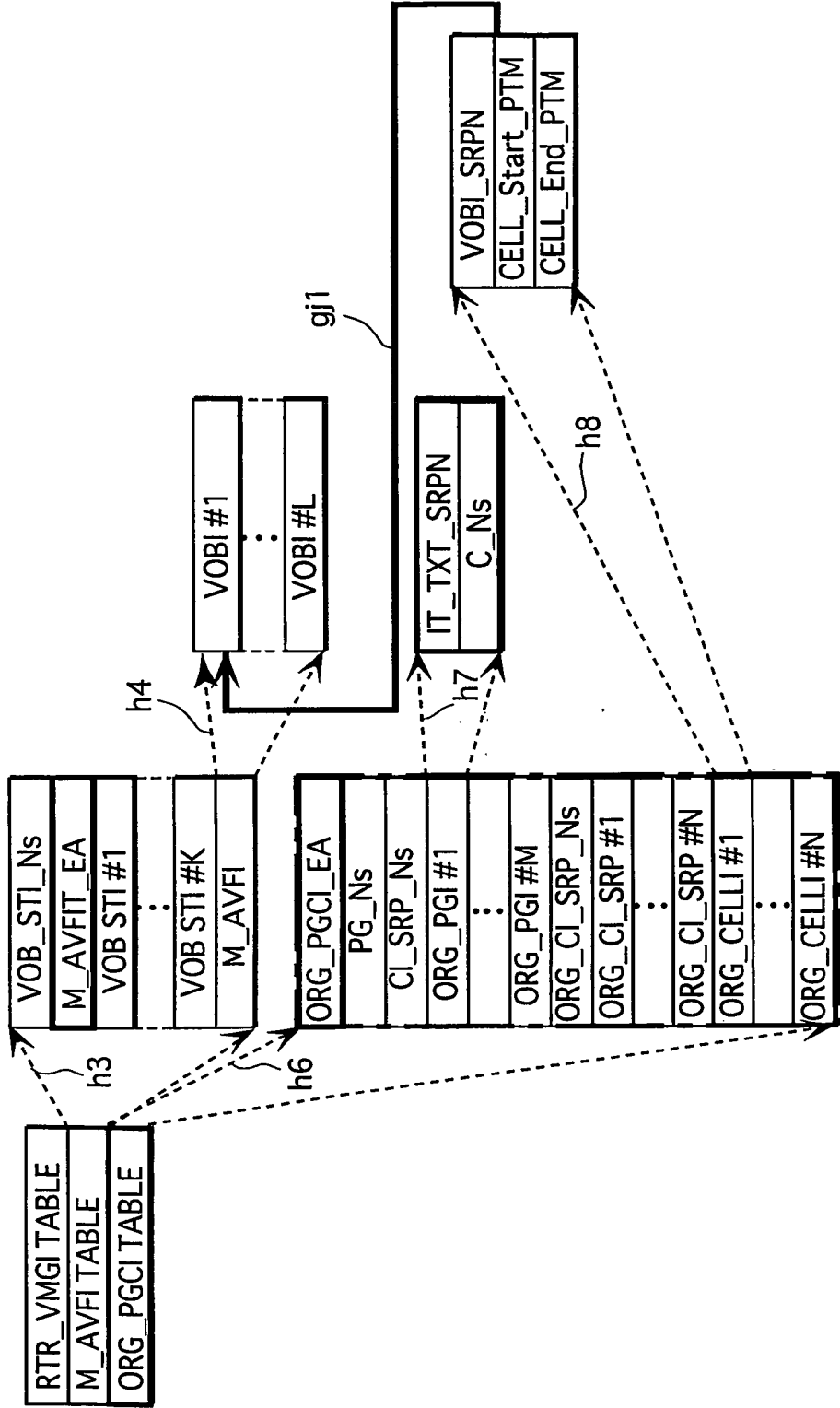


FIG. 3.2

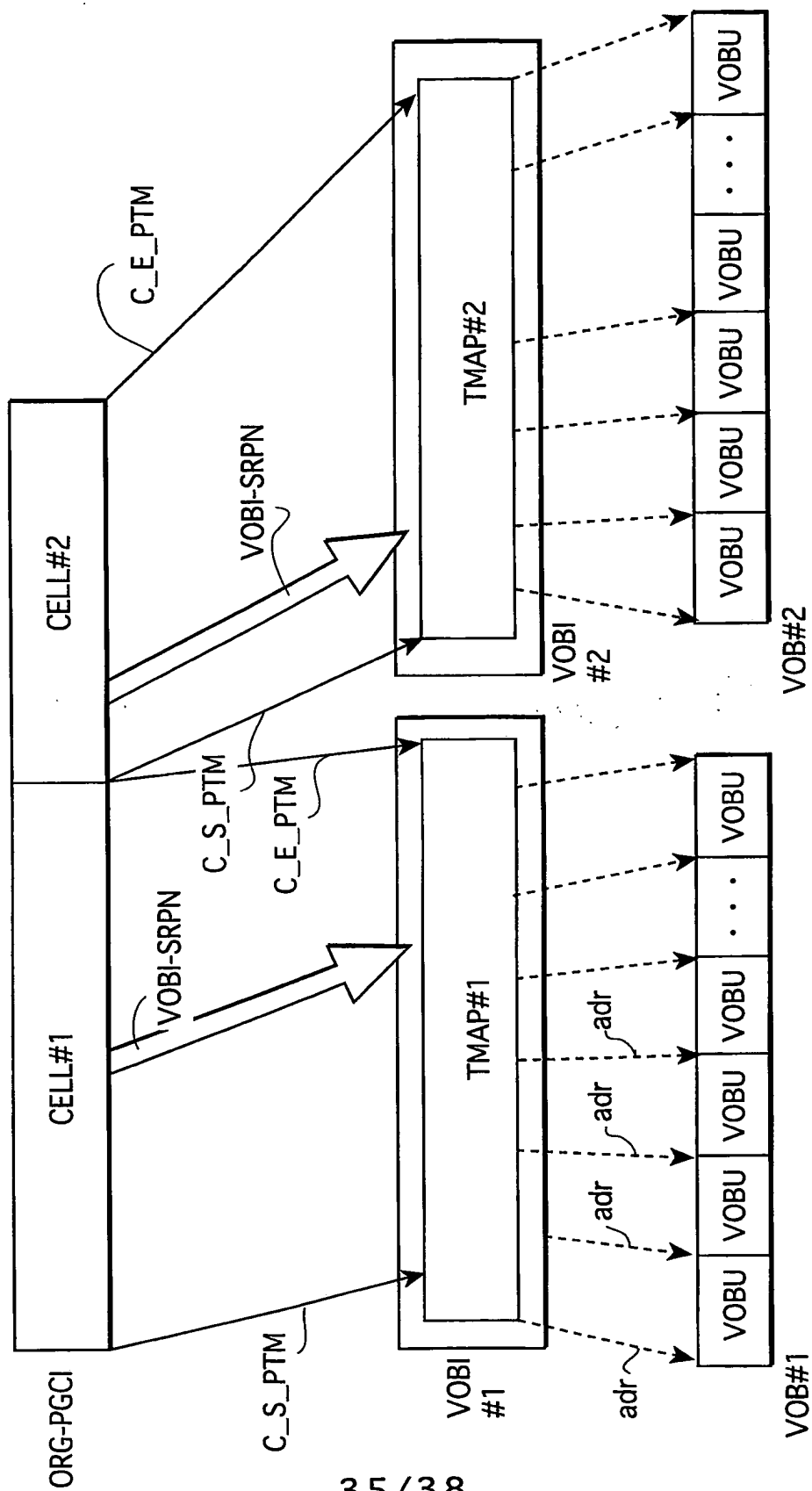


FIG. 33

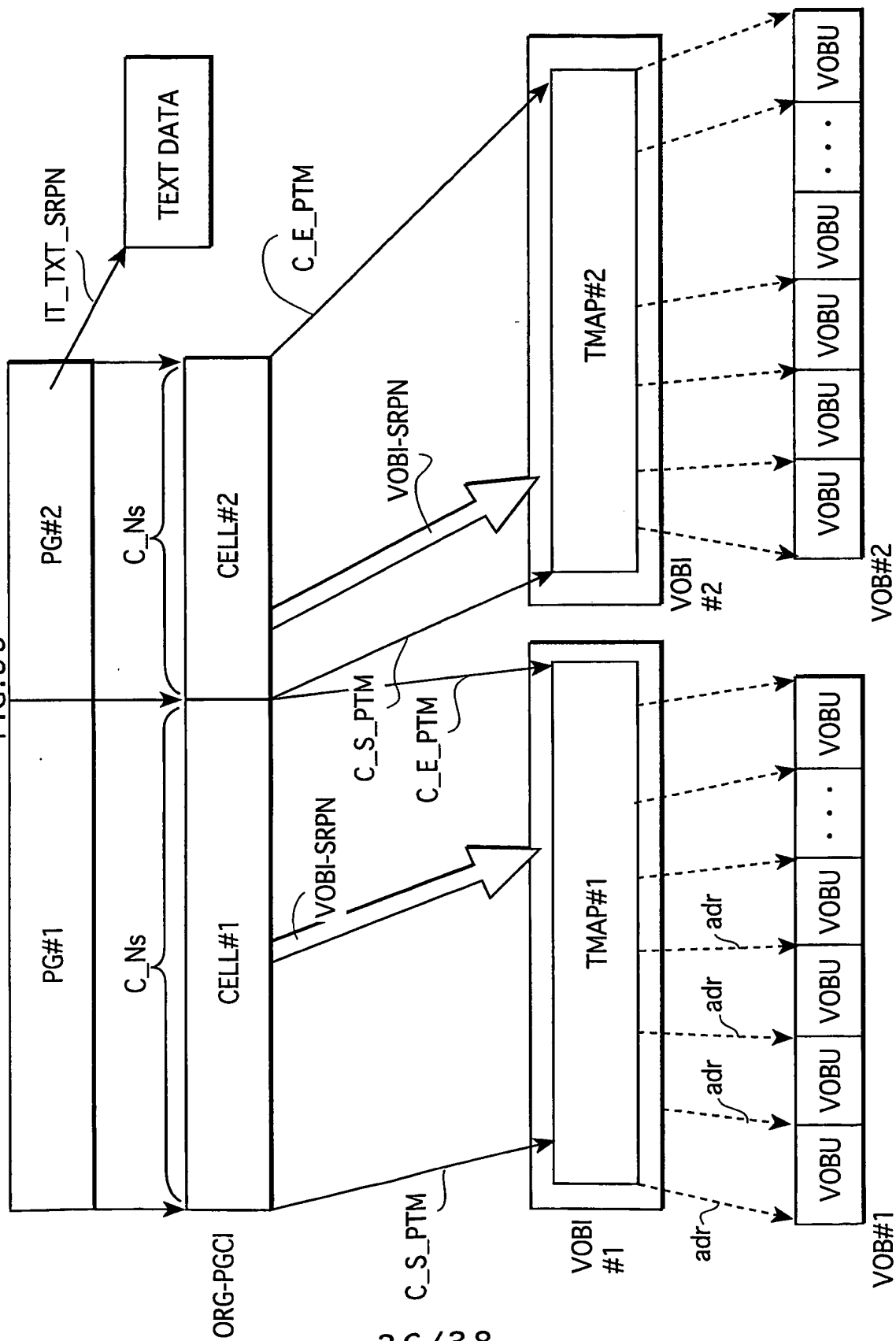


FIG.34A

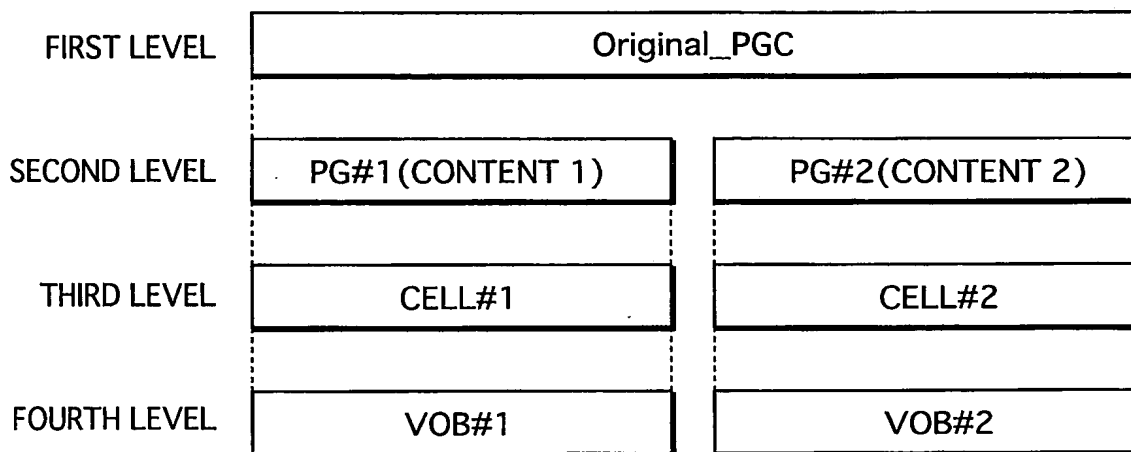


FIG.34B

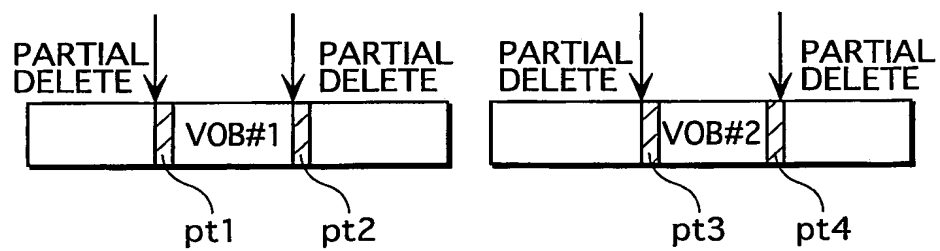
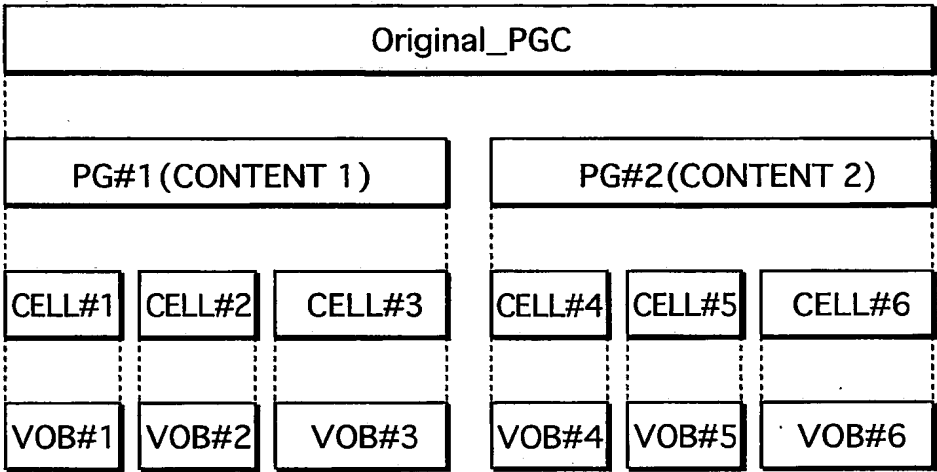




FIG.35



# INTERNATIONAL SEARCH REPORT

Intern. Application No  
PCT/JP 02/13414

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 G11B27/34 H04N5/445

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G11B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 1 158 795 A (SHARP KK) 28 November 2001 (2001-11-28) paragraphs '0047!', '0048!', '0077!'-'0079!; figures 2,4-11	1-39
Y	WO 01 45391 A (KELLOCK PETER ROWAN ;KENT RIDGE DIGITAL LABS (SG); GOH LIANG KEE ( ) 21 June 2001 (2001-06-21) page 8, paragraph 2 -page 9, paragraph 1; figures 1-3 page 23, paragraph 3 -page 29, paragraph 1	1-39
Y	US 6 118 450 A (GIOSCIA RICH ET AL) 12 September 2000 (2000-09-12) abstract; figures 4-12 column 8, line 13 -column 9, line 65 -/--	1-39

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

14 April 2003

Date of mailing of the international search report

23/04/2003

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## INTERNATIONAL SEARCH REPORT

Intern. Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2001/024562 A1 (YAMAGUCHI NOBUAKI ET AL) 27 September 2001 (2001-09-27) abstract; figures 5-9,11-15 -----	1-39
A	US 5 717 869 A (KURTENBACH GORDON P ET AL) 10 February 1998 (1998-02-10) figures 4-13 -----	1-39

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